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ABSTRACT

Twenty-nine essays in the fields of economics, mathematics, and philosophy are presented in this semiannual report on undergraduate teaching. The articles are researched and written by education journalists, and intended for use by educators in all disciplines. Among the topics included are teaching methods (case-study approach, self-paced instruction, simulation, multisection courses, computer-managed courses, introductory courses for nonmajors, classical methods, minicourses, the open classroom, and optional achievement levels), and overviews of teaching in each of the three disciplines. (MSE)

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Change

The Magazine of Higher Learning

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3 REPORT ON TEACHING

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ANALYSES OF SOME OF THE MOST NOTABLE IMPROVEMENTS IN AMERICAN UNDERGRADUATE TEACHING

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ABOUT THIS SPECIAL REPORT

"Nowadays," wrote Oscar Wilde, "we are all of us so hard up that the only pleasant things to pay are compliments." But are compliments enough? One of the repeated criticisms of Change's Reports on Teaching is that they are too complimentary, too laudatory, too uncritical. How is it, academics ask, that a leading opinion magazine can be so critical in its regular editions and so unmitigatingly euphoric in its special teaching editions?

The answers, I believe, are worth noting. One of the prime purposes of this important report series is to select success stories, as these are generally identified through a sequence of nominating procedures. It would be foolhardy to regard this selection process as scientific. Quite the contrary, it is impressionistic and perhaps on occasion even anecdotal. Nonetheless, we follow certain peer judgments in such matters, a procedure in which the limitations as well as the virtues are generally understood.

There is little sense in selecting outstanding prototypes of anything only to tear them apart by some mystical scientific analysis. The essential success ingredients that go into good teaching can hardly be analyzed scientifically. All we can do is to present some of what are commonly agreed to be among the better efforts across the nation and let the impressions speak for themselves. And for this purpose, I for one far prefer the trained eye of an outside journalist to the cold analysis of a fellow pedagogue, for good teaching remains an art and not a science.

There are no proven and universally adaptable recipes for effective teaching. We can respect the idiosyncratic nature of a particular learning situation and yet recognize that the wider encouragement of risk-taking by teachers will inevitably lead to a more vital enterprise.

—George W. Bonham

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THESE REPORTS ON TEACHING: Progress and Prospects

Many of you may be receiving a Report on Teaching for the first time. Or perhaps you are a *Change* subscriber, wondering how these Reports fit into the regular cycle of a monthly opinion magazine on higher learning. For both audiences, it might be helpful to review here the purposes of these Reports.

Change Magazine, because of its leadership position in higher education, often responds to the needs of the academic profession in ways other than through its pages. It does so through conferences, studies, and books, and by identifying and speaking out on public policy issues affecting education. Among these is the challenge of enhancing the quality of undergraduate teaching.

One way to approach this challenge is to help the scholarly societies encourage effective teaching among their members. In December of 1974, Educational Change, the parent organization of *Change* Magazine, surveyed the executive directors of more than 20 of the major disciplinary associations. They were asked whether they might be interested in working with us to prepare a series of special issues devoted entirely to undergraduate teaching. The courses or programs to be described would be selected with the help of the associations. And, in the tradition of the magazine, the articles would be researched and written by education journalists, whose objectivity as observers and clarity and style as writers would result in a publication that could be understood and enjoyed by chemists as well as philosophers, mathematicians as well as historians. The response from the scholarly societies was unusually positive, and six months later, with the financial support and encouragement of the federal Fund for the Improvement of Postsecondary Education, the program was begun.

The purpose of this program is twofold: first, to encourage the improvement of undergraduate teaching by directing national attention to some of the many efforts of professors to better their teaching at colleges and universities across the country; second, to reinforce and support the work of the associations in this area. While varying greatly in staff size, structure, and membership, nearly all of the associations are becoming increasingly concerned with the quality of teaching in their undergraduate courses. More attention is being paid to teaching at national and regional association meetings and through association journals and newsletters devoted to teaching. Participation in the *Change* program means for some associations an extension of their own work in this area; for others, it provides the support needed to stimulate fledgling efforts by association members to draw attention to what goes on in the classroom.

Report on Teaching #1 was published in March 1976 and covered teaching in chemistry, history, and psychology; Report #2 in July 1976, covering biology, English, and political science. The fourth Report on Teaching will be published in July 1977. Two of the three disciplines will be sociology, through the American Sociological Association, and geography together with geology, with the help of the Association of American Geographers and the American Geological Institute.

All of the Reports are distributed to the regular subscribers of *Change* Magazine. Copies are also sent to faculty in the three disciplines appearing in the Report. This is done with the generous help of the disciplinary associations. We are most often able to reach department heads in all two- and four-year institutions and perhaps subscribers to the disciplines' teaching journals or members of the teaching divisions, all of which depends on the availability of mailing labels—the keys of access to your mailbox. Copies are also distributed by the associations at their regional and national meetings.

Finally, we are able to reach many individual professors with the help of over 200 faculty development centers, consortia of institutions, and state and regional associations that request bulk orders for distribution. The response from this group has been particularly encouraging, and we are especially pleased to be able to offer the Reports as a supplement to the efforts of these very worthwhile programs. Many of these groups have found the Reports to be helpful in stimulating discussions and encouraging seminars and meetings devoted to teaching. Kenneth Erfft of the University Center in Virginia, a consortium of 15 colleges in the state, has said that the Reports have made it possible for the University Center "to provide its membership with a series of broadly based programs that are proving to be the highlight of our programs for the year and involve greater numbers of individual faculty members than anything we have done before."

We hope to be able to continue our work for a third and final year and include other fields, such as physics, foreign language studies, anthropology, and interdisciplinary programs. The continuation of the Reports depends on whether funding is renewed and on the responses we receive from readers. Both the staff of *Change* and that of the Fund for the Improvement of Postsecondary Education welcome your reactions. If you find the Reports valuable, wish to offer suggestions or criticisms, or want further information, our address is: Teaching Project, *Change* Magazine, NBW Tower, New Rochelle, NY 10801. We would like very much to hear from you. □

WHAT IS IMPROVED TEACHING?

by L. Richard Meeth

When this project was launched, one of the first staff conferences centered on the question, What is improved teaching? The question continues to come up each time a teaching experience is reviewed. Then as now the choice of the word "improved" was intentional.

Other terms were discussed and rejected. One option was to talk about "good" teaching, but that implied some absolute standard of goodness that has yet to be identified. American higher education has rarely focused on how to achieve a minimum or optimum standard but rather has concentrated on how to bring about more practical, thoughtfully considered ways of improving the art.

Another option was for us to talk about "innovative" teaching, which, in fact, many people equate with improvement. Innovation suggests an approach that is new or different. Some people think of innovative teaching as special. Others think of it as worthless (untested is untrue) and still others see it as a way of teaching that is obviously beyond the resources or the energies available.

A third choice was to talk about "unique" teaching, in the sense that a particular experience is different from other attempts to achieve the same outcome. But many excellent teaching experiences have been created many times over by different people in other settings with equally effective results. So good teaching is rejected because it presumes an absolute standard, innovative because it emphasizes newness, and unique because it suggests a one-time-only experience. All three words are too limiting to cover the range of growth that is taking place among teachers in higher education.

Why talk about the outcome rather than the process, improved teaching rather than improving teaching? We have talked about the act of improving for a long time in American education without specifying where we wanted to come out. What is the purpose of a journey without a destination? Some description of the dimensions of improved teaching may provide goals against which concerned educators can assess their progress; it may also help explain how and why a particular experience appears in the pages of these Reports.

There are some things that improved teaching is not. Improved teaching experiences do not necessarily have universal applicability. Some are limited in the ways in which others can adapt or adopt them, though most have dimensions—either principle, process, or product—that others can utilize. Readers of these Reports are occasionally disappointed to discover that all activities described in their disciplines cannot be reconstructed in whole or even in part. Unfortunately, there is a human tendency to reject that which cannot be absorbed totally, but the examples printed in these Reports are all selected because they have at least some dimension of universality.

Improved teaching does not mean, in the words of Jerry Gaff, director of the Project on Institutional Renewal Through the Improvement of Teaching, that all examples of it are "complete models of effectiveness." Most improved teach-

L. RICHARD MEETH directs the Change Magazine Project on Undergraduate Teaching. He also teaches at the State University of New York at Buffalo.

ing, in fact, is not as effective or complete as those who direct it would like. But by unconsciously imposing absolute standards on others' attempts at bettering their teaching, observers frequently fail to recognize the extent of change that has taken place. All teachers are not at the same place on any continuum of improvement. This project has occasionally reported experiences that were at a simpler, more fundamental level than those of many faculty teaching in that field. If the context of a teaching experience does not exactly coincide with the perspective of an observer, he or she too often rejects the total improvement, failing to see the principles or the pieces that could fit his or her setting or, worse yet, failing to see that contexts can be changed as well. It is disheartening to see a faculty member visit a colleague and fail to grasp the significant changes in an improved teaching situation because of some imposed standard or expectation of completeness.

Improved teaching is not popularizing the obvious or mundane body of information normally communicated by pedestrian teachers. The popularizer has his place in the circus of education, but to mistake popular for improved teaching is to look only at superficial teaching techniques without regard for substance.

Improved teaching does mean, however, that the experience is better than the way the teacher taught it before, but not necessarily better than anyone has ever taught the course or structured the experience. The distance a teacher moves in understanding how to make his or her teaching more appropriate, meaningful, effective, or whatever the word might be depending upon the criteria used to assess improvement, is one critical dimension of improved teaching. But all improved teaching does not change enough to make any difference. Some that is better than it was may still not be good enough in that students, in spite of the improvement, do not learn any more or at all from the teaching. So there must be other aspects as well.

Improved teaching must mean that students learn more from the experience than they learned before. The outcome or the product must be greater or better. To focus entirely on what the teacher did to structure the learning experience is to leave out a fundamental criterion. But even when students learn more from the improved teaching than they did from the previous experience, outcome cannot be the exclusive criterion of definition. Rate of improvement and change in students are only two parts of the larger whole.

So improved teaching means that the instructional process is less ambivalent, more pointed, more efficient. In an intermediate sense, the teaching process flows more directly out of its purposes. The learning activities that link purpose with product are more obviously and directly apparent. When there is congruence among purposes, activities, teacher, and learner, the participants tend to know it. At this point the art of teaching comes through most clearly.

As with any art form, when it is done well the whole is greater than the sum of the parts. There is a synergism about improved teaching that comes through in the way both teacher and student respond, though it frequently defies capture. When writers and photographers seek to report examples of improved teaching in these Reports, they often say that the writing fails to convey the spirit of the experience. Because teaching is both craft and art, there is a spirit about improved teaching that may not be replicable.

Finally, improved teaching means that a particular learning experience reflects the force of a professor who, in the words of Kenneth Eble, "has paid attention to teaching," made notable changes in the ways he or she directly or indirectly affects learning and attitudes about learning, and consciously helped others see some applicability to what they do elsewhere in their own teaching. There is a self-consciousness about improved teaching that comes after any pilgrimage, but because the activity is teaching, the pilgrim has the opportunity to reconstruct both the pain and the joy from the time and place when he did not know if his journey would be effective to the point when the whole is recognizably better.

Is there a conflict between improved teaching and sound scholarship? Can knowledge be both well taught and well reasoned? Yes to both these questions. Conflicts result when overemphasis on either teaching or scholarship puts the scales out of balance. Improved teaching is ultimately, in the words of William Arrowsmith, "the molding of men rather than the production of knowledge."

Thus these Reports on improved teaching. We hope that these thoughts will expand the discussion and explain a little more about how examples have been selected for publication in these special issues. There seems to be little future in limiting either the praise or the evaluation of teaching to good, innovative, or unique examples when broader, more comprehensive criteria and definitions can be applied to a larger number of faculty in American higher education. □

ECONOMICS

ECONOMICS FOR THE MANY

by G. L. Bach

The newspapers say that economists are in the doghouse because we didn't predict accurately the combined recession and inflation of 1974-75 and because we haven't explained how to eliminate these twin evils. But the undergraduates don't seem to have heard about it. They are flocking to economics courses on campuses across the country in unprecedented numbers. Indeed, troubled times in the economy seem to produce large enrollments in economics courses.

The problem in economics, therefore, is not to get students to fill up our classes, but what to teach them and how to do it most effectively. My ideas about the questions currently troubling thoughtful teachers of undergraduate economics these days run as follows.

What to teach? Leading economists have long agreed that economics is not a set of answers to problems, but rather a way of thinking about problems. It is fundamentally a set of analytical concepts and principles, and a way of applying this analytical tool kit to the issues that economics deals with. Thus, the difficulty is not the range of issues to be considered (inflation, unemployment, poverty, rent control, and so on). Rather it lies in deciding what is the most fundamental set of analytical concepts and principles that will be of general usefulness to the learner in thinking independently about an unknown and unknowable range of problems in the future; and what to teach about how to apply these analytical tools to the changing world. Today's "answers" are dangerous learning indeed if students go away thinking they can be applied to tomorrow's problems, which are certain to be very different.

Many thoughtful teachers, increasingly convinced that most undergraduate economics courses try to teach far too much and end up teaching very little of lasting value, impose a five- or ten-year test as to what is worth teaching. Will the student remember and use what is taught years later, long after he has escaped the threat of the final exam? If not, it's not worth teaching today. This is a tough test, but I have long thought a proper one. It calls for clear thinking about what is truly fundamental and ruthless paring back of what is nice but inessential. It calls for developing skills in applying concepts and principles to a wide range of problems and situations. It permits student attention to a lot of the facts about today's world, but mainly as they relate to basic concepts and principles. Students can learn a great deal about how to solve problems by guided experience in working out a sample of them. But this line of reasoning stresses: Don't make a fetish of facts.

To state these general propositions is easy. To devise a lively, fundamental course that stresses such learning is difficult indeed. And to teach a course with emphasis on such student learning calls for the highest order of teaching skills. So viewed, what to teach becomes inseparable from the question of how best to teach it—how to aid students to learn to become flexible, independent thinkers about economic problems.

In an increasingly complex, formal, mathematical discipline like economics, where graduate work and research increasingly emphasize intricacies and elegance of reasoning, it is particularly difficult to keep these qualities from displacing more fundamental values in undergraduate teaching. This is especially true for new PhDs, who know that prestige and promotion ride largely on demonstrated skills in the fine points of their disciplines. Proving existence theorems and stability conditions may be the proper fare for advanced graduate courses; but as teaching materials for undergraduate courses they get demoted firmly to the sidelines. It is relatively easy (though not easy to convince beginning teachers) to cut out the most esoteric fare—but deciding just how far to pare back the analytical tool kit for Introductory Economics, or for an

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intermediate international economics course, is far more difficult.

Nor have most undergraduate textbooks in economics been much help. Though increasingly lively for the basic course, most have been encyclopedic, attempting to cram a little of everything into the student's head without a clear learning philosophy. And increasingly, the leading books for the more advanced undergraduate courses have fallen into the trap of emphasizing the technical apparatus of the field, rather than fundamental, flexible student learning for independent future application.

How to teach it? Perhaps what most troubles thoughtful teachers in economics, as in other disciplines, is how little we know about how students learn. The psychologists have told us some fundamental things about what produces learning: Motivation matters, and no one will learn much economics when he is not moved to do so. Prompt feedback is important to learning for most people. Learning lasts longer if it is relevant and reinforced. And so on. Surely we need first to understand as much as possible about the conditions under which different people learn different things best if we are to be effective teachers. Most of us have done very little to find out what is known about learning. That is a number one question and a very troublesome one.

If one accepts the preceding argument about what to teach, it has strong implications for how to teach. Students are very unlikely to learn the central principles and how to apply them independently and flexibly unless teachers design courses and follow classroom and out-of-class procedures that stress and develop such learning. So, another central question: How best to design such a course, and what pattern of teacher-student interaction is likely to maximize such learning? Over the years some of us have developed strong views on this question, and some evidence to back them up, but this must still fall into the troubling-question category.

A decade ago, the American Economic Association's Committee on Economic Education faced up to the fact that unless we can somehow measure the results of different kinds of teaching, we cannot say meaningfully which is more and which is less effective. Together with the Joint Council on Economic Education, we sponsored development of the basic Test of Understanding in College Economics (TUCE), which is carefully devised to measure the abilities many economists think most important—stressing (alas imperfectly) the general focus outlined above under "What to teach?" Hundreds of thousands of copies of this test have been used over the past decade. The Association is convinced that a new and better version is needed, and we hope to produce one soon.

Given this and other tests of teaching effectiveness, the Committee has done everything possible to encourage more careful research on the issue of relative effectiveness (in results relative to costs) of different teaching methods, using, in at least some cases, carefully designed research experiments with appropriate control groups. Again in cooperation with the Joint Council on Economic Education, the Committee sponsored a new *Journal of Economic Education* for publication of precisely such studies—both to disseminate the results and to improve the professional publication reward system for research on the teaching of economics as well as on economics itself.

The following pages of this issue report some of the teaching experiments that have been tried and evaluated, though only a small sample of them. The widely used TIPS system of substituting computer-aided learning for routine faculty and teaching assistant review was first developed by Allen Kelley in economics. Careful measures of the effectiveness of programmed learning, independently and when combined with the case method, have been devised. Experiments with student self-paced learning are being evaluated. A massive controlled experiment comparing the results of alternative teaching approaches for different kinds of students under different learning conditions is now in its early stages. And many more. We badly need better answers to this set of questions on "How best to teach it?"

Lastly, a related but different kind of question, crucial in economics as in many other disciplines: In an increasingly complex, formal, and sophisticated discipline, where the academic payoffs to young people are largely for research, how can we improve the payoff possibilities for good teaching and increase the incentives to care about fundamental teaching, which is, alas, difficult and time consuming? Again, it is easy to report the question, much more difficult to answer it. The Association's Committee on Economic Education has long put this at the top of its agenda. It has devised an elaborate set of activities to help generate the desired kinds of behavior by individual teachers and, equally important, by senior members of the profession who pass on the rewards to young economists. We can report some highly encouraging results from a project (financed by a generous quarter-million-dollar grant from the Sloan Foundation) to aid major graduate departments to build training in teaching (along the lines indicated above) into PhD programs, which in economics largely focus on building research skills. The program is now being used in eight major universities; we hope it will be picked up by at least a dozen more in the next few years, bringing this emphasis to at least 200 or so new economics PhDs each year.* □

*For further information, write to Arthur Welsh, Joint Council on Economic Education, 1212 Avenue of the Americas, New York, New York 10036.

SHOULD CINCINNATTI BELL CHARGE EXTRA?

A CASE-STUDY APPROACH TO ECONOMICS

by Evan Jenkins

Case study, a staple of law and graduate business schools for some time, is a relative newcomer to economics, particularly at the elementary level. But over the last several years Rendigs Fels, professor of economics at Vanderbilt University, has developed an introductory course using cases from the real world to bring alive—and drive home to students—the principles of basic economics.

The teaching method Fels prefers for the course is the personalized system of instruction (PSI), which is self-paced and requires students working individually with proctors (each proctor is assigned 10 students) to demonstrate mastery of a succession of assignments. Because of a heated dispute over academic credits for the undergraduates serving as proctors, however, Fels faces what he calls a roadblock. He is not sure whether his course will be taught with PSI at Vanderbilt again.

However that dispute is eventually resolved, there is general agreement that development of the case-study approach to introductory economics has been valuable, one intriguing alternative to the standard lecture-plus-textbook, touch-all-the-bases survey course that has been the norm. Fels, long among the most outspoken critics of that norm, has proceeded from two assumptions in attempting to change it. One is that some understanding of economic principles, and some ability to apply them, is valuable for everyone. The other is that most students in an introductory course are not prospective majors—that, indeed, many will never take another economics course. Thus Fels's major aim is to teach students to think during the course in a way that will be useful later when, as nonspecialist citizens, they encounter economic policy questions.

"In principle," declares the foreword to a casebook Fels and a colleague have written, "a person with a liberal education might take a lively interest for the rest of his life in economic theory rather than policy; but in practice a person with one semester or one year of economics will promptly forget the theory unless he has developed an interest in applying it to what he reads in newspapers and magazines. For purposes of a liberal education, theory and application must go hand in hand."

And so the cases Fels gives his students are drawn from the real world as reflected, for the most part, in the press. Students are asked to apply the principles of economics to such matters as the Cincinnati Bell Telephone Company's decision to charge extra for information calls; inflation policy as set forth by President Ford in a speech to Congress; the impact on employment, inflation, and corporate spending and profits of efforts to eliminate air and water pollution; and ticket scalping at Madison Square Garden.

One of Fels's first tasks when he went to Vanderbilt in 1948, having completed undergraduate and graduate study at Harvard, was to serve on a three-member committee to overhaul the introductory economics course. "We decided to start each section with a policy problem," he recalled recently in his office in Vanderbilt's musty Old Central building. "We'd present the problem to the class, develop the analytical tools for solving it, then go back to the problem. The point was to show them that we weren't just dealing with armchair theory." The course was revamped along those lines, but Fels's dissatisfaction remained. "It was always a matter of going on from where we were, of doing better and doing more," he said.

Twenty years after the first overhaul of the Vanderbilt course, Fels got a chance to do something on a larger scale about his dissatisfaction. The Joint Council on Economic Education, in cooperation with the Committee on Economic Education of the American Economic Association (AEA), decided to try to develop a number of alternative approaches to teaching an introductory course. Fels, a member of the AEA education committee (he is also treasurer of the AEA), volunteered to head a project at Vanderbilt.

An economics department colleague, Ewing P. Shahan, became codirector of the project. A graduate of the Harvard Business School, Shahan knew and liked the case-study method from his time there and suggested that it form the basis for a model course. Choosing appropriate, timely cases and writing the right questions about them was not easy, Fels and Shahan say, but over several years they and a then-graduate student at Vanderbilt, Robert G. Uhler, compiled a body of material to which students could apply the principles of such basic economic matters as supply and demand, allocative efficiency, national income accounts, and the theory of income and employment. The material was put together in a casebook, with Fels and Uhler as coauthors. Now in its third edition, it contains three parts—microeconomics, macroeconomics, and staff notes.

EVAN JENKINS is an assistant news editor of the New York Times. He is the paper's former national education correspondent.

In "The Vanderbilt-JCEE Experimental Course in Economics," a detailed description, complete with syllabus, of the course as it would be taught with PSI, Fels discourses in footnotes about what he views and condemns as the standard overloading of introductory courses in his field. "Highly trained economists," he charges, want to teach "all the theory they learned in graduate school. The urge to teach too much—the input-output fallacy of thinking that the more you put into a course the more the students will get out of it—permeates the teaching of economics.... The choice of two kinds of courses boils down to which is more important, coverage or mastery? I opt for mastery. I suspect that everyone else would too if they knew how to achieve it."

That was written in 1974. Fels's stand has not changed since then. "In my view—it's obviously a minority view in the profession—you should teach a much more limited amount and teach it thoroughly," he said in a recent conversation. "And you should train students to make use of what you're teaching them."

In practice at Vanderbilt, according to Fels, he has had to live with a compromise between mastery and coverage. "The casebook takes the place of some readings," he said, "and I've left out some chapters of the text, generally those dealing with application of principles, not the principles themselves. In my opinion the introductory course here is still excessive, but I alone don't determine what the course has to cover."

For supply-and-demand analysis, the casebook uses an example called "Information, Please." It is representative of both the source of cases (real events of economic interest reported by the news media) and the analytic method Fels seeks to impart. The case is based on a news item distributed by United Press International and published in newspapers on February 27, 1974. Cincinnati Bell, the item reported, would allow its customers three free calls for information a month, then charge 20 cents for each subsequent call. The Company's explanation was that it was deluged with information calls, often for numbers listed in the directory, and that the problem was costing inordinate amounts of operators' time and company money.

Students analyzing the case are asked a set of questions designed to find out whether they understand: the government (regulatory) policy problem raised by the case; two main criteria for deciding policy for the problem; the major economic concept useful for analyzing the problem; and the relative merits of the policy options in light of the goals (criteria) chosen for deciding policy. Then the students are asked to offer a conclusion.

Those questions about the telephone case closely parallel a five-step standard operating procedure Fels and his colleagues have devised to get students, as Fels puts it, "beyond mere rationalization of preconceptions." The staff notes provide sample acceptable answers (but not the "right" answers, since conclusions depend on judgments involving both the facts and the student analyst's values).

The casebook is in use to varying degrees at nearly 200 colleges around the country, sometimes for intermediate as well as introductory courses. In most cases it is used in conjunction with standard lecture courses; a lecture on a principle is followed by discussion of a case applying the principle.

At the Clearwater campus of St. Petersburg Junior College, a modified version of the full Vanderbilt-JCEE course, using PSI, was taught in 1974. The instructor, Scott McCuskey, found the case method "a very appropriate method toward meeting the need for relevancy and rational decision making in economics." He concluded that it made "concepts more meaningful and interesting for the great majority of students. Also, there were strong indications that the case method may be a key to retention of knowledge." McCuskey reported, however, that students generally did not achieve the success in problem-solving skills and techniques he had anticipated, a disappointment he attributed primarily to insufficient time and practice.

At Vanderbilt, only Fels has taught the model course with the PSI method, but the casebook has been adopted enthusiastically there by some colleagues for standard courses and has been tried and found wanting by others. Shahan uses it with his introductory course because, he says, "It focuses the student's interest on real economic problems. He really gets involved." Is learning improved? "We can't get measurable results showing what students are learning. It's a phenomenon throughout the educational world—all tests measure what people have memorized, not how deeply it sinks in. But we've done extensive questionnaires among students, and we know they like it. They think it makes the material more meaningful and applicable and provides clarification and insight. These cases can't be memorized; the student has to think, and he has to use what he's memorized."

> **"The typical course in elementary economics does try to teach too much, to cover too many topics; efforts to reduce the number of topics covered are to be welcomed. The use of cases in teaching can be helpful, provided the cases are carefully chosen to help students develop the analytical skills they need.**
>
> *R. A. Gordon, University of California, Berkeley*

Another professor of economics at Vanderbilt, William O. Thweatt, tried the case-study approach and abandoned it. "I felt like Leonard Bernstein with no orchestra," Thweatt recalled. "I was the only one doing anything. I always have big classes, and with the cases you have to have a lot of discussion. It wasn't happening. The cases are good. I like them. I—and I underline that—couldn't get the students to read them. Rendigs is a master of the Socratic method—the ability to ask questions, get things out of students, but keep it orderly, not let it get too diffuse. The case method requires that. I tried and failed miserably. On the other hand, I'm very much biased toward the lecture system. And I think I'm good at it."

Fels has been known to declare the lecture system obsolete, but always with a major qualification—the exceptionally good lecturer, a category in which he would include Thweatt. "I would never argue against a good lecturer's lecturing," he said. "I do think the use of the lecture method in general stems not from high ability, as it does in Thweatt's case, but from the subject orientation of the instructors. They think of themselves as economists, not teachers. They know their subject, and they like to parade their knowledge."

Students who have taken the introductory course from Fels express virtually unqualified enthusiasm, but it was difficult in conversations with several of them to discover the sources of the enthusiasm. Fels as teacher was clearly one source, the PSI method another, the case-study approach another.

"For me, it was an excellent way to learn economics," said Robert Mitchell, a junior from Bloomfield Hills, Michigan, and a chemistry major. "The casebook was excellent. I had friends who took other introductory courses, and they got a lot of theory but no practice. I'd recommend the course to anybody. I guess it's hard to say whether it was Dr. Fels or the course itself that made it so good, though. If you didn't have him in there, it would be a good idea, but it could bomb if the proctors were poor, say, or the teacher didn't care."

Michael Cook, a fourth-year graduate student who said he "learned a lot about teaching" from his work as Fels's teaching assistant, praised the case-study system, too. "When we went to the cases, you could see that a lot of people who had been bored, confused, or uncertain suddenly felt they were accomplishing something. Some responded quite dramatically, raising their grades a whole notch. They were more confident."

The only formal evaluation of the course as taught at Vanderbilt is the Siegfried-Strand study, funded at Fels's request with money from the initial JCEE grant. The study was directed by John Siegfried and Stephen H. Strand, both members of the economics department at Vanderbilt when the study was done in 1975. It focused on a comparison of the performance of students under PSI and in a conventional course and found only one significant difference, a subjective one that the authors nonetheless considered important: "Students liked the PSI course more, thought they learned more, and felt they were examined and graded fairer in the PSI course."

The evaluation also found that "the student-proctors learned more economic theory than they would have learned from an alternative upper-class economics elective." Siegfried, in a separate examination of that question, concluded that "the proctors would improve their scores on an economics exam 2.7 times the improvement by students who elected to take an advanced economics course instead."

Armed with those findings, Fels proposed that the proctors be given four hours of academic credit for their work—an hour for the seminar course in which they prepared for the task, three hours for the semester in which they actually tutored 10 students each and, according to Siegfried, absorbed considerable knowledge. The proposal encountered stiff opposition with the faculty at Vanderbilt outside the economics department on several grounds.

Some critics were skeptical of the Siegfried findings. They questioned the amount of new learning involved for the proctors, as distinct from reinforcement of material covered in earlier courses. Another argument was that payment in money was the appropriate compensation, as it was for graduate teaching fellows and advanced undergraduates who worked as assistants in other departments. Some opponents attacked the whole proctor concept as exploitation of students taking the introductory course who had paid tuition and were entitled to be taught only by members of the faculty. "But the basic question was the awarding of academic credit," said one opponent of Fels's proposal who asked not to be quoted by name. "It was not whether Ren should give the course. I think everyone saw a lot of merit in that."

Robert Donaldson, a political scientist who is associate dean of the College of Arts and Sciences and chairman of the curriculum committee, supported Fels's plan and was very impressed, he said, with the Siegfried report. "The case-method approach was not an issue," he said, "and there was no opposition to PSI as such. The arguments were all on the academic-credit question, and it was clear from the outset that the full proposal would not get to first base."

A compromise was struck in the curriculum committee and approved by the full faculty on October 21, 1975, after what Donaldson described recently as heated debate. The course would be taught for two years on an experimental basis. The proctors would receive two hours of credit for the preparatory seminar, which would have an increased workload, and one hour for the proctoring semester.

The outcome upset Fels. He felt the academic rewards for the proctor were inadequate. (Payment in money, he said, would have been unjustifiable economically; the course "would no longer be cost-effective.") The only student who has worked as a proctor for credit under the compromise arrangement—in an accelerated version of the PSI course taught to a small class last May—declared in an evaluation of the experience that "I have learned an incredible amount," but said the academic "remuneration" was "chickenfeed" for the work involved.

As this was written, Fels was uncertain whether he would teach the PSI course again. Besides what he considers questions of fairness, he was doubtful about getting enough qualified proctors under the compromise. "I'll see how many sign up for the preparatory seminar," he said. "If I get an adequate number, we'll proceed. But I'll tell the prospects what the score is, and we'll see what happens."

In a talk in which Fels showed obvious signs of discouragement, he said at one point, "I now think it was a mistake to accept the compromise. Maybe I should have made an issue of it. I probably would have gone down fighting, but maybe I wouldn't have gone down."

He continues to hope that the faculty will reverse its decision. So does Donaldson, the curriculum committee chairman. "I hope after the two-year experimental period and further evaluation Fels's proposal will get through," he said. "For that course particularly, it just doesn't make sense to have it taught just one way. It would be a real shame if he doesn't teach it again. I'd hate to see us lose a very viable and successful option in the teaching of introductory economics." ■

Learning experience:
Elementary Economics. No prerequisite. Enrollment: varies from 12 to 100.

Other descriptions:
"The Vanderbilt-JCEE Experimental Course in Elementary Economics," *The Journal of Economic Education*, Special Issue No. 2, Winter 1974.
"Teaching Economic Principles: The Joint Council Experimental Economics Project," *American Economic Review*, February 1977 (forthcoming).
"Is Teaching the Best Way to Learn?" *Southern Economic Journal*, January 1977.

Similar programs:
Saint Petersburg Junior College, Clearwater campus.

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Less an Experiment Than an Art Form — An Introduction to the Social Sciences

To Kenneth and Elise Boulding, professors of economics and sociology respectively at the University of Colorado at Boulder, the course they have devised in the basic social sciences is "more like a work of art than an experiment." It is also, they add, fun for student and teacher alike, and unique in the perspective it provides on society.

An Introduction to the Social Sciences, a one-semester course launched on a grant from the Joint Council on Economic Education and originally intended for freshmen, has developed into a multifaceted effort to give students a sense of the essential unity, coherence, and validity of the social sciences. First offered by the Bouldings in the spring of 1972, the course was taught in 1976 by Guy Burgess, a PhD candidate at the University who assisted with earlier versions of the course.

The guiding light of the course is EXOC, a spherical green intelligence composed of selenium and silicon who makes his home in a "hive" near Arcturus, some 30 light years from the earth. EXOC's compatriots, beings of an advanced civilization, picked up the earth's first radio broadcasts in the 1940s and, alarmed at these signs of activity from a previously silent planet, sent EXOC off at the speed of light to investigate. As the semester begins he has encamped on the moon (the earth's atmosphere being fatally oxidizing), made telepathic contact with the Bouldings, and demanded information. The class thereupon turns into a research institute to inform EXOC about the earth, and particularly about its social system.

The dramatic device of EXOC forces the students to look at the earth as a total system, rather than a mass of unrelated circuits. It brings up the concept of the sociosphere—a terrestrial unit at least as ordered and coherent as the biosphere, the atmosphere, and the hydrosphere. And it illustrates in all their complexity the problems of sampling large systems, the dangers of generalizing from a biased sample of reality—such as the radio and TV broadcasts EXOC has been monitoring—to the world at large, and the inevitable errors produced by too heavy a reliance on personal experience. Students are assigned the tasks of correcting all of EXOC's media-induced misconceptions and providing some balanced picture of the history of the world. The need for social science and its concomitant tools is shown to arise precisely because personal experience is so limited.

As they wrestle with the problem of introducing EXOC to the earth, students come to appreciate the need for data collection and analysis, and to understand the preoccupation of social scientists with numbers and percentages. Like generations of social scientists before them, they are forced into abstraction through theory and statistics—into social science knowledge derived from specialized human activities.

The coursework consists mainly of exercises: 15 assignments that have proven satisfactory to both students and teachers as the course has evolved. One of these is the Bouldings' random history project, in which students sample the 70 to 80 billion human beings who have lived on earth.

Each student draws from a hat a time and place from the earth's last 4,000 years: The contents of the hat have been weighted roughly in proportion to the number of humans who were there. The student is then dispatched to the library to do research on the location and decade chosen—Cambodia, for instance, in 810 B.C.—guided by an outline, a time chart of human history, and bibliographic references. Most students are amazed that U.S. history is rarely drawn in the sample (since Americans comprise no more than .005 of the humans who have ever lived). They come to realize that history as they have encountered it in school is a very biased sample indeed, and that the society in which they live is unusual almost to the point of absurdity.

Students progress from this general viewpoint to the particulars of the social system at the present time. They are supplied with a data book giving values for some 56 variables—economic, demographic, and sociologic—for the major countries of the earth today. Using these statistics they work with elementary correlations involving 2x2 matrices (latitude versus per-capita GNP, for instance), compute simple regression coefficients, and experiment with the balance-of-payments matrix for three interrelated parties.

Exercises of a more sociological slant involve work with family trees and the dynamics of population growth and inheritance. Simulation games such as William Gamson's SIMSOC, in which students create an entire new society and cope with its problems, have proven very effective.

In 1975 a survey was conducted of the 50-odd students who had taken the course as freshmen in 1972. Only about a third could be contacted, and this very imperfect sample indicated only that students were rather sharply divided into those who were stimulated by the course and those who were not. A standard University end-of-semester questionnaire in 1976, however, elicited many responses of "quite worthwhile." Student complaints about an excessive amount of course busywork have been largely eliminated as the content of the exercises has been adjusted.

A more formal evaluation of the course will be forthcoming after spring of 1977, when a preliminary version of the course materials, including the EXOC story, the data book, and the exercises, will be published by Addison-Wesley, Inc., of Reading, Massachusetts, and test taught across the country. This may be obtained at cost by any teacher who wishes to try out the material; there seems no reason why the course, which requires no prerequisites, cannot be used in the last year of high school as well.

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BRIGHTENING THE DISMAL SCIENCE

by Judith Miller

Elisabeth Allison sat comfortably at her desk, surrounded by stacks of papers, economics textbooks, and computer printouts. "You know," mused Allison, an associate professor of economics at Harvard University, "economics is a lot like skiing: Both are great fun to do, but terribly frustrating and painful to learn."

For the past five years, Allison has been experimenting with a method of making economics more fun and easier to absorb. She and her colleagues are succeeding. Well, half succeeding. The method being tested at the Harvard economics department is called "self-paced instruction" (SPI). And after four years of evaluation, the studies indicate that while economics students do not seem to like the subject any better, SPI students are learning more of it.

There is nothing terribly innovative about self-paced instruction, as Allison is the first to acknowledge. She borrowed it from Paul Bamberg, professor of physics at Harvard. He borrowed it from MIT. But SPI (or, variously, the "personalized system of instruction") did not originate within the Ivy League. It was developed about 10 years ago by Fred S. Keller, a professor at Arizona State University. Since then it has been used mostly in psychology courses, in the hard sciences, and recently in political science (see "Equalizing the Opportunity to Learn," Report on Teaching #2, July 1976). Allison's role and contribution have been twofold: First, together with Otto Eckstein, Lucius M. Littauer professor of political economy at Harvard, she has adapted SPI to economics; and second, since the program's inception, she and Eckstein have scrupulously measured, tested, and questioned the student consumers of the method to produce an extremely detailed assessment of SPI's strengths and weaknesses.

The department might not have tried SPI at all had not Derek Bok, Harvard's president, raised money for a fund for innovative projects for Harvard undergraduates. That was in 1972. Once funding was available, Allison and Eckstein turned their attention to methods of improving introductory economics. "Harvard's introductory economics course was by conventional criteria a good class," said Allison. Although it is not required of any student except economics majors, it has traditionally been one of Harvard's largest undergraduate courses, with annual enrollments of 600 to 700 students. More than half of all undergraduates have taken it by the time they graduate.

"Despite the course's good ratings and popularity among students," Allison said, "we realized after each set of final examinations that only a small minority of the students had gained any deep understanding of the course material, particularly its theory." So Ec. 10, as it is known, was the logical place for improvement.

It was decided to experiment with SPI as a means of solving what were considered the deficiencies of the conventional course where, recalled Allison, "feedback to the student was insufficient. Often it was not until after the first exam that the student realized he had not truly absorbed the material being presented. He then had to wait another two months to test his understanding again."

Allison believed that the conventional method of teaching introductory economics, partly because of the lag time between teaching and testing, did little to encourage better teaching. Moreover, because only one or two tests were given during the semester, it was difficult to evaluate how well specific material was being communicated to the students. Finally, the final exams usually revealed that much of the time and effort the student had spent were misdirected; students, in sum, usually absorbed the wrong information—the facts rather than the theory. The self-paced program of instruction seemed to be the best hope of remedying these deficiencies. So in the fall of 1972, the department launched what it then considered its experiment with SPI.

The self-paced system has two essential features: first, a list of course goals, specified in practical, operational terms; and second, a set of exams that the student is asked to take when he feels he has mastered one of the objectives. Immediately after taking the exam, the student sits by a grader and watches him correct the exam. If he fails, he is awarded an incomplete; there is no penalty. He is told why he failed and shown

JUDITH MILLER is the Washington correspondent of The Progressive.

the areas in which his grasp of the material is weakest. He is then encouraged to return and take another exam on the same material as soon as he feels he is ready. Full credit is awarded for passing the exam regardless of how often it is taken.

Because no one was initially convinced that SPI would work, the program was launched with the care normally afforded a scientific experiment. It was designed from the beginning for evaluation and assessment. In the fall of 1972, three of the course's 30 sections (84 of the 756 students) were assigned to SPI sections or classes. Assignments to SPI classes were made so as to match students in conventional sections with respect to predicted grade point averages, mathematical background, actual or intended areas of concentration, and years in college.

Because of this careful selection process, students were not permitted to transfer in or out of SPI sections. Two of the sections were self-paced for both semesters; the third was taught in conventional fashion for the first semester and self-paced the second in order to allow comparison by sections. The students in SPI sections were simply told at the beginning of the semester that they were in an experimental section, and were given a brief description of the self-paced method, a list of goals or objectives corresponding to the major topics on the standard reading list, a set of section notes, and a schedule of eight exams. Apart from the self-paced information, notes, and exams, conventional and SPI students were given the same material.

Students in all sections were encouraged but not required to attend their sections three times a week in addition to the coursewide lectures given by the "stars" of the economics department. All students were responsible for the reading list and were assigned identical papers and problem sets. All students were required to take the midterm and final examinations. The final exams were graded by number, rather than name, so that examination papers could not be identified with a particular section or student. In addition, all students were asked to complete a questionnaire evaluating the course at the end of the semester.

Allison and her colleagues were pleased and somewhat surprised by the results of the first year of SPI experimentation. They found that SPI appeared to increase the amount of information economics students had absorbed. On the final exam with a mean score of 137 and a range of 75 to 170 (of a possible top score of 180), SPI instruction raised grades by an average of seven points or, on their grading scale, slightly more than one fourth of a grade. In addition, most students seemed somewhat happier with the course and more comfortable with economics than students in conventional sections. And finally, more students decided to major in economics. Traditionally, about one third of the freshmen in the course chose to concentrate in the field. Among SPI freshmen, roughly 80 percent decided to do so.

Further testing has added to and refined those initial, very tentative results. In fact, Allison is proudest not of SPI itself, but of the department's assiduous evaluation of the program—of the application of standard economic tools to measure achievement. And four years of experimenting with SPI have substantiated the department's initial findings that SPI does teach students more. However, Allison also discovered that despite an initial period of enthusiasm, students are not happier in self-paced courses than in conventional classes.

Nevertheless, SPI seems to produce a 10 to 15 percent improvement in achievement on final exam scores. Perhaps most important, SPI significantly improved the performance of students least prepared for success in the course—those with the lowest SAT scores—students from minority groups. Moreover, women students have also benefited especially from SPI; traditionally, women have not fared as well as men in economics at Harvard. "In sum," concludes Allison, "minorities and women stand to gain the most from SPI, but all students do better."

The department has made several other interesting discoveries about teaching in general while evaluating the self-paced method. It found, for example, that student ratings of instructors do not correlate with achievement. On the other hand, the better the instructor's grades in graduate school, the better the students did. Moreover, the greater the number of hours an instructor spent preparing for his section, the better the students' performance. Finally, the greater the number of problem sets an instructor handed out, the better the students did. "Given these correlations," wrote Allison, "we've concluded that the greater the amount of time and effort an instructor spends on his class, the better his students will do. However, the instructor's time and effort do not seem to affect student ratings and preferences for instructors, which only indicates that students are not very good judges of good instruction."

Because the instructor is such a key factor in the SPI achievement equation, the economics department recently launched a program to strengthen instructor teaching skills—a teacher training seminar. At Harvard, as at most large undergraduate institutions, Ec. 10 sections are taught by graduate students or junior faculty members, and about two thirds of these instructors teach the course only once.

> **"What is particularly commendable about Harvard's experiment with self-paced instruction is the careful system of evaluation that accompanied it. Greater individual attention, stimulating the student to keep up with the course and not rely on cramming, and opportunities for repeated evaluation and self-evaluation are likely to pay significant dividends.**
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> *R. A. Gordon, University of California, Berkeley*

Learning experience:
Introductory Economics: self-paced, full year course covering micro, macro, and applied fields. Enrollment: 130.

Other descriptions:
"Three Years of Self-Paced Instruction at Harvard," *American Economic Review*, May 1976.
"Self-Paced Instruction in Economics," paper #368. Cambridge, Massachusetts: Harvard Institute for Economic Research, Harvard University (available on request).

Similar programs:
University of Nebraska at Lincoln, State University College at Buffalo, Vanderbilt University, Northern Illinois University.

Contact:
Economics 10 Office, 1737 Cambridge Street, Room G-6, Harvard University, Cambridge, Massachusetts 02138, (617) 495-2167 or 495-2109.

Two years ago, the economics department instituted an economics teacher training seminar. Initially the program was funded by a $1,500 Danforth Foundation grant. All Ec. 10 instructors are now required to take the two-day seminar, held prior to the beginning of fall semester. The seminar is highly structured and concentrated and relies heavily on videotape as a vehicle of instruction.

The heart of the seminar is "microteaching." The instructors are divided into groups of 4 or 5 participants with a group leader—an instructor or professor who has taught the course before. Each participant is asked to prepare 3 to 5 minutes of a lecture. In the group, he delivers the lecture and is videotaped. The tape is replayed as the group leader calls the instructor's attention to substantive problems with the lecture—such as an attempt to cover too much material—and stylistic difficulties. Distracting mannerisms and speech habits are noted. The instructor then delivers the lecture again and is retaped. "Because the feedback is so immediate and irrefutable," said Allison, "it is possible to change behavior dramatically in a short period of time."

While visiting Harvard, I saw a typical before-and-after critique tape of one instructor's performance, a graduate student from Israel. The improvement was truly remarkable. During the first tape, the instructor was ill at ease, spoke much too rapidly, tried to explain virtually all of economics in three minutes, shifted from one foot to the other in a distracting manner, never used the blackboard to illustrate a point, and jumped illogically from one topic to another. The second tape produced an instructor who spoke slowly and comprehensibly, used the blackboard, made simple, straightforward points, and narrowed the focus of his lecture to provide a framework for the course which students, and even the lay reporter, could understand.

In addition to the video microteaching sessions, the instructors are taught how to handle irrelevant questions, the necessity of preparing several different explanations of troubling points, how to involve the student in class discussions, and how to plan and organize a course effectively. The teaching seminar has proven to be remarkably successful for preparing instructors for the task ahead, both conventional and SPI classes.

Another important factor affecting SPI success and the cost of the method is the SPI exam grader. It is the grader who corrects SPI exams with the students and gives them the bulk of their immediate feedback. Harvard hires one grader for every 8 to 10 students. Graders are expected to explore correct answers on exams with students as well as incorrect ones, to determine whether the student truly understands the material. At Harvard, graders are seniors or first-year graduate students who are paid for their work. But at many of the institutions that use SPI in economics, graders are upper-class economics students who are given course credit for their work.

Allison estimates the first-year costs of implementing SPI at Harvard at $3,000, but that figure includes Harvard's elaborate evaluation system. "The cost of SPI is really pretty minimal," she says. "After all, a self-paced course is simplicity itself: You don't need capital-intensive teaching machines, educational television, and computers; all you really need is a room, pencils, paper, students, and instructors."

The cost of SPI may also be somewhat higher if one chooses to assign a value to student time. SPI students, judging from the opinions of both students and instructors, spend two extra hours a week preparing for SPI exams. "Initially, we were concerned that SPI was simply an elaborate system for squeezing more time and effort out of students," concedes Allison. "And yes, we have found that SPI students spend more time on

Teaching Economics With the PLATOnic Method

Difficult, frustrating, and unrewarding: that's how many undergraduates view the study of economics. At the University of Illinois at Urbana-Champaign, Donald Paden is beginning to change those attitudes with help from a computer-based teaching system called PLATO (see "The Potential of PLATO," *Report on Teaching #1*, March 1976).

About 250 undergraduates are now using the system in Introduction to Economics to study a Supplemental Economic Package that focuses on six areas: supply and demand, perfect competition, imperfect competition, the determination of level of income (with and without government), and fiscal policy. In the latter area, for instance, a freshman economics student is actually able to explore the alternative fiscal policies that the federal government has available.

Should the federal budget be balanced? Should taxes be cut? Should there be an increase in federal expenditures? Previously, sheer lack of time and the ability to solve the required equations kept students from tackling such problems. Not so with PLATO, which makes use of a display format similar to a TV screen and a keyset for communication with a computer. Students not only solve the equations but they also see the results plotted on graphs on their screens.

The system presents instructional material, asks questions, judges the students' answers, responds to mistakes, and stores information about student behavior. Paden considers the system an important supplement to conventional texts, programmed material, lectures, quizzes, movies, workbooks, tutors, and television. And it guarantees a certain amount of study—students are required to use PLATO on a regular basis.

Overall, the student response has been favorable. "The PLATO lessons are extremely helpful" is a typical reaction. In fact, generally favorable results have been obtained with the system since 1969, when it was first introduced as a supplement to conventional classroom instruction.

At first, a small group of students used PLATO to study the first three lessons of what is now the Supplemental Economic Package. Later, a study management system was developed in cooperation with the University's Department of Educational Psychology and with funding from the U.S. Navy. During the first year of the project, 228 students were assigned randomly to two PLATO classes and two classes that were not using PLATO.

The texts, instructors, and exams were the same for both groups. PLATO students were required to go to the PLATO terminals, sign in, and read a short assignment in Paul Samuelson's *Economics*. On completing the assignment, students re-

the course, about 20 to 30 hours more than the conventional student studying economics. However, the self-paced student usually winds up spending far less time preparing for the midterm and final examinations."

Allison acknowledges that it took several semesters to debug SPI: to correct weaknesses in the teaching method, develop course notes for the program, and improve the important grader/student relationship. The department, for example, had initially feared that students might take one SPI exam too many times and fall behind the rest of the section. They considered imposing a limit on the number of times a student could take each of the eight exams. But the problem never became serious: Most students take SPI exams twice; many average three to four times; but almost all of the students complete the SPI exams by the final.

Allison also admits there are several issues about which there is still considerable uncertainty. She is still concerned, for example, that there may be less tangible educational costs inherent in the self-paced system. "In self-paced, the student does not spend his time sifting through masses of material to find a conceptual core," says Allison. In other words, SPI courses do the conceptualizing for the students, set up behavioral objectives, and so on. An exclusive diet of SPI could thus be detrimental by denying students the opportunity to develop such skills on their own.

It has also become clear that some kinds of material are well suited to SPI instruction while other kinds are not. Over the course of the year, it was found, for example, that topics such as the history of economic thought and economic development are not particularly well suited to the self-paced method.

Finally, despite all of the evaluation, very little is known about how and why self-pacing works, about what is crucial to the system. If one gives students objectives, without self-paced exams, or exams without objectives, would SPI still be successful? The Harvard experiment has shed little light on the answers to such questions. These lingering doubts do not seem to have inhibited the spread of SPI in economics, however. It is now being used at about 80 colleges and universities throughout the country, including Vanderbilt, Boise State, Weber State College in Utah, the University of Oregon, Oklahoma State, and Northern Illinois.

At Harvard, SPI is gaining popularity among students. Nicholas Fish's enthusiasm about the method is typical. "I don't see why every Ec. 10 student doesn't sign up for it," said Fish, a Harvard freshman from Washington, D.C. "Despite the extra time I put in, and I have taken some of the exams four or five times, it's just so much easier to learn economics step by step, making sure that you really understand the material as you go along. I thought, for instance, that I understood the concept of elasticity. After I received an incomplete on the third exam, I realized I didn't." Fish also said that he wasn't particularly interested in economics when he came to Harvard, but that now he's thinking of majoring in it.

"I guess the ultimate test of SPI is the student consumer marketplace, or at least we economists like to think so," said Allison. "And given that indicator, there's every reason to believe that SPI is a success." This year, students were permitted to sign up for self-paced instruction classes rather than the conventionally taught sections. More than 100 students did.

SPI may not be the answer for every economics department, but given the results in Cambridge—the enthusiasm of instructors about the method, and the improvement in student achievement scores, especially among minority students and women—Allison is sold on the concept for Harvard. And so is Harvard. ■

turned to the terminal for a short quiz on the material studied. After reaching a specified level of understanding, the students went on to other assignments and tests.

About two thirds of the PLATO students thought the course was good or excellent and indicated they would take another course taught in the same way. More importantly, the results showed that the two PLATO classes performed better than the control classes. "The process of asking questions seems to facilitate learning," observes Paden, who gives much credit to the educational psychologists who helped devise the study management system.

At present, the PLATO system in economics, which is currently being supported by the Illinois Council on Economic Education, offers six lessons that must be completed at specified intervals during the introductory course. Each lesson requires many responses, which are graded, along with a 10-question review quiz. Students now study from Paden's *Introduction to Economic Analysis*, which contains specific lesson objectives covering short reading assignments. Using the computer, the students must take (and may retake) unproctored one-hour exams. They also take quizzes that focus on text material. Lectures, for the most part, cover current topics. The students are required to take a written midterm and a final. Time permitting, the study management quizzes will be reintroduced as they are revised to go with Paden's text.

Paden has kept several notions in mind while developing a PLATO system for economics students: Students probably should receive only part of their instruction via PLATO—lectures and seminars should remain part of the college learning experience. The use of the computer should not be excessive. (The study management system, for instance, took about 45 minutes of student time each week, as is true of the present program of six instructional sequences and computer exams.)

In addition to improving student understanding and helping to dispel the attitude that economics is difficult and frustrating, the PLATO system allows the computer to handle such housekeeping chores as grading and record keeping. Without taking up the instructor's time, students get immediate grades for their responses and continuous feedback on their progress. "Everyone gains," says Paden, who notes that only the limitation of access to terminals prevents more widespread use of the PLATO system.

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GAMESMANSHIP IN MACROECONOMICS

by Peter Binzen

In every Presidential election campaign—fall 1976 being a good example—the country's economic system moves into the spotlight. The political parties adopt platforms spelling out their economic policies. The candidates find experts who insist that their man's plans make far more sense than the baleful notions of the opposition. And when it's all over, few taxpayers know much more about the American economic machine than they did before the campaigning began.

One reason for this lack of comprehension is that the U.S. economy is extraordinarily complex. Even economists don't agree on what makes it run in fits and starts, or how it can be made to function at peak efficiency. Beyond that, though, there is a suspicion among some economists that the public at large is mostly in the dark because economics is taught badly in schools and colleges. In the minds of many it is a dismal science best left to the experts. Not enough high schools attempt to teach economics. For college undergraduates, its workings are rarely analyzed in depth.

Back in 1968, three economists—F. Trenery Dolbear, Jr., then at the Brookings Institution; Richard Attiyeh of the University of California, San Diego; and William C. Brainard of Yale University—pinpointed the problem. "The few quantitative studies that exist and our biannual despair upon reading our students' exams," they wrote, "suggest that undergraduate teaching [of economics] falls far short of acceptable levels of effectiveness.... We feel that most students do not acquire an adequate understanding of what economic theory is or how it relates to either economic policy or everyday economic events."

The three were convinced that conventional teaching methods had failed. To find students "passively poring over pages of textbooks" and taking down the professors' pearls of wisdom for later memorization made no sense. Far better, they concluded, to teach economics by having students "actively participate in the learning process, receive continuous feedback, and have the opportunity to repeatedly apply new ideas in a variety of contexts."

To make all this possible they devised a game simulating the economy of a mythical country; students who play the game by computer become the economic policy makers for the make-believe nation. They are assigned a policy problem, such as the attainment of a targeted Gross National Product (GNP) growth rate. By examining "historical" data they attempt to determine the behavioral characteristics of the economy. They then make policy decisions and instruct the computer to change the appropriate policy variables, such as taxes or government spending. The computer instantly determines the reaction of the economy to the changes ordered by the players of the game. The students see, through examination of revised statistical data, what effect their policies have had. The game then advances from Year 1 to Year 2. With the new statistical record, players are asked to deal with new problems. And so on for 18 years. The game gets more complicated as it advances but a knowing student might complete 18 years as an economics panjandrum in about one hour at the computer. Like an actual policy maker, he must live—from one computer game year to the next—with the consequences of his mistakes. If he errs in one period, his problems mount for the next. Hence the aggregative nature of the game.

Gaming was introduced in a special section of a macroeconomics course at Stanford University's Graduate School of Business in 1967. Variants of the simulated policy game for teaching macroeconomics are now or have been used at Yale, Michigan, Wesleyan, Swarthmore, Drew University, the University of Delaware, and untold other places. Dolbear, currently professor of economics at Brandeis University, has been using several different games for his students there.

The game Dolbear was using in the fall of 1976 was one he and Brainard designed for the Esmee Fairbairn Research Centre, Edinburgh, Scotland, and for

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students at the University of Essex in England, where they were both visiting professors in 1975-76. Dolbear, 42, whose doctorate in economics is from Yale, spent a year at the U.S. Bureau of the Budget as a Brookings Economic Policy Fellow in 1967-68. He has had practical experience in the world of economic policy, and his game is intended to give students a blend of the practical and the theoretical.

But rather than describe it to a visiting reporter, Dolbear swung around his office chair to a printer hooked up to Brandeis's computer, punched out a password, and was greeted with: "Welcome to UKMCR1. What is your name?" Dolbear replied that his name was Ace. With no more ado, the computer began spitting out game-opening statistics relating to UKMCR1's GNP, potential GNP, consumer spending, gross investment, government spending, taxes, and disposable income. A code was used: Q for potential GNP, Y for GNP, G for government spending, T for taxes, and so on. Each account was assigned a number. UKMCR1's GNP stood at 77.0, its potential GNP at 80.1, its government spending at 15.5.

These statistics indicated that UKMCR1's economy was lagging. The lag was shown by the 3.1-point gap between its actual GNP and potential GNP. Potential GNP is achieved at a time of high employment and high utilization of plant and equipment. The computer informed Ace (Dolbear) that "the government has decided to try to achieve full employment by increasing G by 3.1 [the gap between Q and Y] while holding T constant."

In other words, UKMCR1 boosted government spending by exactly the difference between GNP and potential GNP with no increase in taxes. But Ace (and, one assumes, his class) saw the error. It ignored the multiplier effect. In the computer game, an increase of one point in government spending means a rise of four points in GNP.

As a result, UKMCR1's rise of 3.1 points in government spending sent its actual GNP soaring by 12.4 points to 89.4. Meanwhile, there was a natural growth of just 2.4 points in the potential GNP—to 82.5. The big jump in government spending with no change in taxes thus overheated the economy. "Policy for Year 1 was, as you can see," the computer told Ace, "a disaster. The government has been thrown out in a vote of no confidence and a decision has been made to seek advice from competent economic experts. (That's you.)"

And so the game gets going in earnest. To bring GNP and potential GNP close together in Year 2, Ace is told he can change government spending but not taxes. What does he do? Well, he knows that potential GNP will rise 3 percent a year—that is a given in the game. Three percent of 82.5 puts the potential GNP at 85. Last year the actual GNP was 89.4. How to get it down to 85? Since the multiplier effect—in this case a negative one—is 4, Ace reduces government spending by 1.1. That gives the 4.4-point reduction needed to balance GNP and potential GNP.

In the third year, UKMCR1's potential GNP rises to 87.5. Ace is asked to calculate the change in government spending needed to make sure that actual GNP keeps pace with potential GNP. The answer, given the multiplier effect, is 0.6. Easy. But now the game gets tougher. In the fourth computer year another variable is added. Ace is told investment by the private sector will rise by 3 points. He is authorized to change both government spending and taxes to deal with the new situation. He knows—and Ace has told his class—that the investment multiplier is also 4. Potential GNP is now at 90.1. With no change in government spending or taxes, actual GNP would go up by 12 points or more than 9 points too much. To bring it into equilibrium, Ace calls for a reduction of 2.3 in government spending.

At this point the game gets too complicated for a novice to understand without a basic grounding in economics. Variables pile up. By Year 14 the computer is rattling off: "The gnomes of Zurich have persuaded the chancellor of the necessity for a balanced budget as a condition for continued support of the pound. Consequently, you should aim for full employment with a balanced budget. You will be permitted to change both G and T."

The computer scores Ace's work year by year. To maintain a balanced budget with full employment in Year 18, Ace raises taxes by 10.2 and government spending by 8.6. GNP thus matches potential GNP but disposable income falls sharply and consumer spending also drops. In a final word from the computer, Ace is informed: "Experts from the Cambridge Department of Applied Economics have pointed out in a letter to the *Times* that achievement of all of these objectives at once is unlikely. The loss associated with your policy is 40.3. Optimal policy, which requires taking a few derivatives, is a G of 62.6 and a T of 60.7. With this policy, consumption, income, and the deficit would have been 57.7, 136.3, and 1.9, respectively, with a loss of 4.0. This ends UKMCR1. Your final score is 89.8. Cheers."

> **66** Simulation games can play a useful role in *intermediate* macroeconomic theory. They help to emphasize that the economy is complex and governed by many interdependent relationships. Yet one problem with a game like the one described here is that it may still leave the student with an oversimplified impression of the economy's behavior—although less so than the exposition in the typical macroeconomic text.
>
> *R. A. Gordon, University of California, Berkeley*

Learning experience:
Intermediate Macroeconomics. Prerequisite: Introductory Economics. Enrollment: 35.

Other descriptions:
"A Simulation Policy Game for Teaching Macroeconomics," *American Economic Review*, May 1968.
"Teaching Macroeconomics With a Computer Simulation" (ED060633), March 1972. ERIC Document Reproduction Service, P.O. Drawer O, Bethesda, MD 20014.

Similar programs:
Wesleyan University, Connecticut (M. Lovell); University of California, San Diego (R. Attiyeh); Yale University (W. Brainard).

Contact:
F. Trenery Dolbear, Jr., Department of Economics, Brandeis University, Waltham, Massachusetts 02154, (617) 647-2781.

Cheers indeed! But if much of Dolbear's game sounds like gibberish, keep in mind that Dolbear's students don't go into it as cold as the readers of this report. The game is an integral part of the student's intermediate macroeconomics course. It's gone over in class discussions. And its various elements are the subject of a series of printed handouts that Dolbear distributes periodically to students.

It would be a mistake to think that Dolbear's game is a way of sugarcoating the economics pill. He does want students to have fun playing it because there are few grins in economics courses. But his primary aim is to provide a new teaching tool that will involve students directly in the learning process while giving them a better understanding of the economic system.

Involvement is a key, and reading textbooks is a passive activity. It is essential for students of economics and for virtually all other courses, but it's still passive. Playing the macroeconomics simulation policy game requires active participation. In moving through 18 time periods, each offering different problems to solve, players get a sense of the aggregative nature of actual economic planning. As we have seen, these are not 18 distinct situations. One builds on another so that bad decisions pile up. As Dolbear tells his students, "You've got to live with your mistakes."

While the game has some realistic touches, it also has some decidedly unrealistic ones, which Dolbear is the first to concede. "It would be wrong and dangerous to think that the real world is as our model says it is," he explains. "Response to economic policies actually takes place over a long period of time. We speed up the adjustment times. The model is very deterministic."

Some of the required moves in the game would be unthinkable in real life. To balance the budget with full employment in Year 14, for example, Ace had to increase government spending by almost 34 points—nearly doubling the previous year's outlay—as well as increase taxes by 43.9 points, which was almost a fivefold hike. No economics minister could survive such traumas.

Dolbear admits that turning students loose in a complex economy "is a bit like throwing children into the water to teach them how to swim." That's why a good deal of classroom preparation is required before his students start chattering with the computer over UKMCR1's problems.

Eldad Ganin, a Brandeis senior majoring in economics, took Dolbear's course in the spring of 1975. It was divided into two segments: the classroom segment and the game, which was a different and more difficult model than UKMCR1's. The class met for three hours a week. "There wasn't enough time to learn economic theory and then put it in practice, all in one semester," Ganin said. All the same, he liked the game and thought that "at least two thirds of the class were as excited as I was.... It reinforced theories learned in the classroom and read about in books. It was even an incentive to read the text. I found myself anxious to read the next chapter to increase my understanding of the variable we were dealing with."

Ganin added that Dolbear "made it very clear that the game wasn't reality. But it was real-worldish in terms of the level of complexity. I've been very critical of intermediate theory-level economics courses," the senior continued. "For reasons of time they can't go into political economics. His [Dolbear's] game is full of political assumptions. Basically, [his assumption is] that the status quo is maintained. There's no room in his course or in any intermediate theory course for discussion of the

The Issues Approach to Economic Literacy

"Every year," says Richard Leftwich, regents professor of economics at Oklahoma State University, "our department tried to find a way to improve the Principles of Economics course. Introducing economics to students was exhilarating, but only for the teacher. The traditional six-hour introductory course has succeeded in turning off thousands. It inspired neither serious study nor even an elementary understanding of the economic forces that determine our well being."

The department wanted a curriculum that would provide practical information rather than theory. Principles evolve from issues, so issues have always crept into the syllabus; they wanted to work the other way around, developing principles, concepts, and theories from actual situations. Issues became the basis of the teaching/learning process, rather than casual applications of theory.

In the fall of 1971 the department decided to discard the two-semester beginning course and substitute two single semesters: Economics of Social Issues, a freshman course, is open to everyone; Introduction to Economic Analysis is listed as a sophomore course to indicate a slightly more advanced level, but there is no prerequisite. The two reinforce each other and can be taken at the same time.

In organizing the first semester, Leftwich and his colleagues decided which principles they wanted to teach, then chose the issues that would do the job. The course is built around a planned sequence of concepts and principles that are used over and over in a set of issues until they're established in students' minds.

There are three meetings a week with about 75 students to a class. Eleven issues are covered, picked for their significance and for their effectiveness in helping students to understand economics. Population growth is the first area studied. In succeeding classes agriculture, higher education, crime, pollution, and health are used to develop microeconomic principles, with questions such as, Should the rich be subsidized? Who really bears the bulk of college costs? How much crime prevention is too much? Can taxation control pollution? and Why have doctors' incomes almost doubled in 10 years? Poverty and discrimination illustrate income distribution, and unemployment and inflation explain supply and demand. The waste of labor resources and Nixon's wage-price control policies are analyzed and the energy crisis is discussed, detailing the effects of the Arab embargo and the use of the price system as a rationing device.

The second course is taught along more traditional lines, concentrating on theory. Students must work harder here, but Leftwich asserts that they're more enthusiastic; those who haven't had the first semester don't do as well as the ones who, learning

sociological or political factors that bear on economic decision making."

Ganin said he considered the game "definitely Keynesian." And Dolbear himself concedes that Milton Friedman, the Nobel Prize-winning University of Chicago economist known for his conservative views on government spending, might not be entirely comfortable with the game. Marxist economists probably wouldn't like it either, says Dolbear, since it does assume that the free-enterprise economic system in this country is workable. Otherwise, however, Dolbear professes to see no strong political bias to the game.

Another Brandeis senior, Teri Huttner, also played the game in the spring of 1975. "It was really beneficial," she said. "It was a tangible use of the theory we were learning. It was hard work. He gave us 24 variables in 11 or 12 situations. We just started setting up equations. I thought it was realistic. In the game, both inflation and unemployment were up. That was just what was happening in this country in 1975. I got very upset. It was like I was trying to run the economy and it wasn't working. What it taught me about the real world is that there's a lot of guessing, crossing fingers, and whistling in the dark."

Dolbear's course concludes with a make-believe press conference. Faculty members are reporters and students are economic advisors. In this bit of role playing, there are prepared statements on the economy, press handouts, and then questions and answers on such matters as inflation, unemployment, and how the pieces fit together. Dolbear sees the press conference as "a good capstone," requiring students to "look responsible" and to think about what they've learned. From the students' point of view, the problem is one of time. Many believe that too much is packed into one term and not enough time is allowed for careful preparation for the press conference.

Although such games are now rather widely used in economics courses, there is no central clearinghouse of information. "Unfortunately, we don't have clear-cut evaluation information," said Dolbear. "Most of my evaluation comes from student comments, which are usually favorable, and from examination questions. Those who play the game regularly seem to be better informed."

At Yale University, William Brainard, who collaborated with Dolbear on the 1968 paper and on UKMCR1, said: "The game goes well when you have an instructor who really cares about it. But it can't be run successfully as a sideshow. If you delegate responsibility to a graduate assistant, it won't work." Like Dolbear, Brainard thinks the game helps students see the gap between the "neat and tidy models in the textbooks and the disorderly world outside."

At the University of California at San Diego, the third collaborator on the 1968 paper, Richard Attiyeh, said the game is played regularly there in a variety of versions. "Students like it," he said. "They learn a lot from it." Attiyeh, with professors in Edinburgh, Scotland, and at Duke University, has a grant from the National Institute of Education to evaluate courses built around the games and to assess their effectiveness for different kinds of students.

At Wesleyan University in Middletown, Connecticut, Michael Lovell said several games have been designed to teach both macroeconomics and microeconomics. "We've been using it for five years," he said. "There's been no formal evaluation but the students like it and seem to learn." The Joint Council on Economic Education has awarded Lovell a prize for his gamesmanship. "The computer should have gotten it," he said. "It does all the work." ■

through the issues approach, have become aware of limits in their analytical skills. By the time students reach the second course, they're anxious for more sophisticated tools.

Economics majors at Oklahoma State have tripled in the past two or three years, but the department's main concern is increasing economic literacy in general. Department heads often ask Leftwich if there isn't some way the course can fit into their curricula, and many departments—including sociology, journalism, and home economics—have taken it on.

An interesting fact emerged when the department was choosing issues for the course: "We were so accustomed to teaching in our own narrow specialty that we didn't know much about what was really happening. We had to dig, and the issues became coffee conversation." The new course was generating learning among faculty. Interest has risen to a point where professors vie for the privilege of teaching the introductory course and it is, in fact, assigned to the most experienced. "This is unheard of in economics," Leftwich says. "Junior professors usually have to settle for it because no one else is interested. If I sound evangelistic it's because I am; this is the most exciting experience I've had in over 29 years of teaching."

The issues approach does attract more freshmen. When it was first offered in the fall of 1971, 135 enrolled. The number increased sufficiently the next semester to bring the total for 1971-72 to 433. Though freshman enrollment fell 18 percent in 1972-73, economics drew 504.

Leftwich used a questionnaire to measure students' feelings about the course: 83 percent found it very successful or fairly successful in stimulating awareness and interest in economic problems; 90 percent thought the issues covered were highly or usually relevant; 61 percent graded it A or B. Many say this is one of their best college experiences.

To find out whether they were learning economics as well as Oklahoma State students who had taken conventional courses, the department spent two years studying the scores of both groups on a national exam designed to measure knowledge gained in economics principles courses. Issues students scored 89 percent of the mean of those who learned by theory. But since the exam was geared to the traditional program, the result is inconclusive. Are the benefits of the issues approach greater than the educational cost? There does seem to be a small sacrifice in the level of economic learning, perhaps 10 percent. But Leftwich believes the enthusiasm and increased enrollment are well worth it.

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RENOVATING INTRODUCTORY ECONOMICS

by Herbert B. Livesey

"Euphemoptimism," one veteran administrator calls it. In the threadbare seventies, the money managers drawn to universities from the corporate and governmental spheres have introduced the lingua franca of the world from which they have departed (and to which they will no doubt return). The campus has become a place, as at GM and HEW, where problems are "challenges" and disasters are "opportunities." Euphemoptimism.

Very well. The challenge: to shape a common core for a multisection introductory undergraduate course while retaining for instructors a meaningful measure of freedom in methodology and content. The opportunity: to inspire an increasing number of students to major in that subject area or at least to choose the basic course as an elective.

Academics frequently mouth platitudes about the primacy of undergraduate teaching, but rarely do they do anything about it until enrollment declines. Indiana University at Bloomington doesn't suffer the diminishing enrollments of many smaller, private colleges, to be sure. Open admission for every high school graduate in the state takes care of that, and the University had over 33,000 matriculants at last count. On the departmental level, however, competition for students persists, and in 1970, the economics department suffered a decline in registration. It was not their first. The chairperson invited Phillip Saunders to join his faculty and do something about it.

What Saunders has wrought is not so much revolution as reformation. As a sympathetic evaluator, Allen Kelley of Duke recently wrote: "Professor Saunders's contributions lie less in the area of course content—the core is rather standard, only a few applications are illustrated, and these are quite specific to individual professors' interests—and more in his interesting and useful presentation of information on...the formulation and evaluation of examinations, the preparation of course objectives, the construction of research designs for appraising teaching, the techniques of coordinating courses with many professors, the alternative ways to use and train graduate student instructors."

In the first four years of the new program, the number of economics majors increased by nearly 60 percent and total students in introductory economics jumped by 53 percent. When Saunders arrived in Bloomington, introductory economics was taught in as many as 20 sections, ranging in enrollment from 30 to 400. It still is. The method was primarily lecture, with as much discussion as instructors chose to permit. Still is. There has been no dramatic installation of audiovisuals or autotutorials, no computer games or peer instruction or self-grading. Classes are held in conventional lecture halls and classrooms, not atop mountains, in barracks, or on the floor of the stock exchange. All these artifacts of fevered innovation were deemed too cumbersome or impractical, given the institutional setting and requirements.

Rather, Saunders and his colleagues sought means by which to make economics comprehensible and usable to students who knew nothing about it before and might never be formally exposed to it again. The trick was to do this without massive infusions of money and without disrupting the collegiality of the faculty assigned to the task. First they divided Principles of Economics into two distinct halves—Introduction

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Phillip Saunders lectures to his own large section of introductory economics.

to Microeconomics 103 and Introduction to Macroeconomics 104. Either semester could be taken, or both, in any sequence. "Most professors would prefer students to take micro first, then macro," says Saunders. "That's starting to happen. At first, there was a preference for macro and its broad concerns. Now students are more interested in microeconomics, particularly in areas such as income distribution and environment."

Saunders's underlying assumption was that "no analytical concept, tool, or model is done well unless a student can use it in the situations and contexts that he or she is likely to encounter in his or her own experience, and in reading of current events in newspapers and magazines." Toward that end he narrowed the material to be covered. "We leave a lot out," says Saunders, "at least it seems so if you compare an outline of our objectives with that of a conventional course. There's something in economics called 'price elasticity of demand,' for instance. It can be taught in lots of different ways. Our exams and homework problems emphasize just the total revenue test: If you raise the price, you're going to sell less. The question then is, Do you make enough by raising the price to justify the loss in unit sales? Does revenue go up with price or down with quantity? If revenue moves with price, demand is 'inelastic'; if it moves with quantity, demand is 'elastic.'

"Simple. With a couple of examples, a student can understand it. But then there's point-arc elasticity and arc elasticity and elasticity coefficients. You can get into all that, but we don't. We want them to be able to grasp the basics. In this case, do they recognize the total revenue test, and can they apply it to things like oil embargoes or raising ticket prices for football games? Other professors ask how we can bypass, say, IS and LM curves. I tell them that we're stressing the application of principles.... The teaching of economics so often gets mired in calculations and formulas that the student is lost."

Saunders does not reject the suggestion that what he and his colleagues are teaching is applied economics, but cautions that the phrase has many interpretations. "Many economics professors will say that they 'start with the problem and then develop the theory.' That's what they mean by 'applied economics.' There's nothing wrong with that, of course, but our approach is quite different. We start with a few analytical tools and then look for problems to which they apply. We believe that if you start with the problems and then go to theory, the problems change every term and, in a way, so do the theories students learn. We want to insure that our students come out with the same set of principles every term."

A reduction in the number of concepts to be mastered, an emphasis on application of those principles to real-world situations—certainly this was a philosophy destined to set professorial wattles aquiver, especially at a time when teachers were objecting to the educational upheavals of the sixties. And there were rumblings about "watered-down pop econ," but Saunders insists the tremors were minor. He notes that student evaluations consistently state that the two courses are the most demanding they have taken, and that the economics department retains its reputation as the hardest grading on campus. "You don't hear the complaint from professors when these students reach the intermediate theory courses," Saunders says. "Our friends in the business school tell us that, if anything, the students they're getting from us know more than they did under the old system."

To minimize the potential for acrimony, Saunders set about achieving consensus as soon as he arrived at Bloomington in 1970. The overhauled courses were to be made available the following academic year. Exchanges of views resulted in syllabi that continue to be modified annually. A recent course description in the University catalog is a clear delineation of intent, however:

> Introduction to Microeconomics: Scarcity, opportunity cost, competitive market pricing, and interdependence are introduced as a basic

analytical core. Individual sections apply these tools to a variety of current economic policy problems such as poverty, pollution, excise taxes, rent controls, and farm subsidies. Major applications for each section appear in the class schedule.

These applications have included, the catalog continues, "urban economic problems, environmental economic problems, government and the economy, capitalism versus Communism, the economics of education, poverty and discrimination, nutrition and the consumer, scarcity and interdependence," and a variety of more limited considerations, such as campus parking, rent controls, the volunteer army, tax reform. While the tools to be mastered and the sorts of applications to be studied are determined in advance, each instructor is free to select the emphasis he or she wants. Students then pick the sections that adhere most closely to their personal tastes or interests.

This leaves the question of measurement. The instrument is a final examination in two parts. The first half is a set of multiple-choice questions common to all sections of the course. The second portion is designed by each instructor—essay or multiple choice or both—solely for that class. Thus the test parallels the course structure—choice and flexibility within a universal core.

Too often, advances in pedagogical technique are trumpeted as solutions for the uncertainties of undergraduate teaching without sufficient basis in experience. Not so with the IU program. Saunders's conclusions are based not upon one or two semesters with small control groups. As this is written, the ninth semester of the courses is under way, and 8,895 students have already passed through.

Of the many findings, these are especially compelling:

•There is a "consistently positive and statistically significant" link between instructor ratings and student performance on the common portion of the final exam.

•Regular members of the faculty are more successful in sustaining student interest in the courses than are graduate teaching assistants, and as TAs become more experienced, their students' test performances improve.

•Grades in the two courses have reflected the declining mean SAT scores of entering freshmen, even though the phenomenon of grade inflation persists on a universitywide basis.

•Instructor behaviors are identifiable as being positive or negative in influencing student performance—and are improvable.

The conclusions linking instructor and student performance are founded on two items: comparisons of core test results and a course and instructor evaluation questionnaire. The response rate to the latter has been good—73.7 percent to 74.4 percent of the students in each of the two courses have answered the questionnaire's 40 items. A deliberate effort was made to avoid questions relating to instructor popularity and personality. According to the studies to date, questions that apparently have the greatest bearing on the instructor's overall rating are:

Instructor seemed very enthusiastic about teaching this course.

Instructor made the objectives and purposes of the course and individual assignments very clear.

Homework, exams, and quizzes seemed clearly aimed at major learning objectives, and did not get bogged down in trivial points or minor details.

Feedback on homework, exams, and quizzes was very good, and enabled me to understand clearly how well I was doing in the course.

Instructor took his teaching seriously and was always well prepared for regular class meetings.

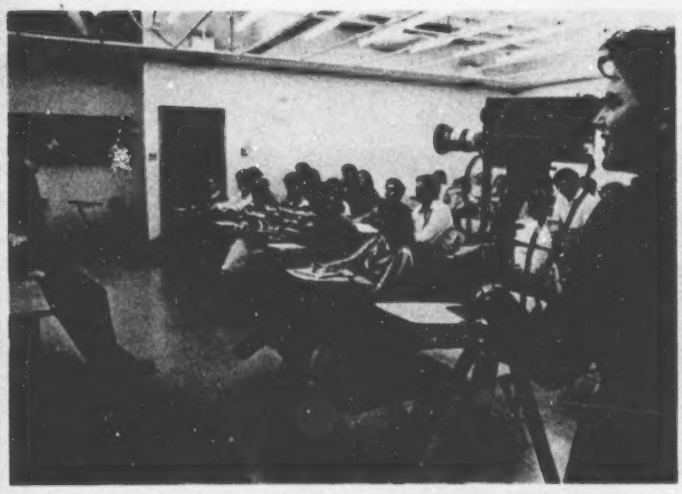
Instructor's voice and speaking ability made it easy to understand what was being said in class.

In explaining difficult points, instructor was able to go beyond the textbook and supply useful examples and applications.

Saunders points out that, with the possible exception of the first item, all these questions deal with behaviors modifiable by instructor training and effort. This discovery led him to establish a graduate seminar in teaching in the spring of 1976. Until then, preparation of associate instructors (as Indiana labels its TAs) was confined to one or two discussions prior to the start of

> **"Certain welcome trends are beginning to be evident in attempts to improve the basic course in elementary economics. These include a reduction in the number of topics covered, greater emphasis on simpler analytical tools and on giving students practice with them on real-life problems, the development of teaching seminars for section instructors, and serious attempts to evaluate success in teaching the course.**
>
> *R. A. Gordon, University of California, Berkeley*

Saunders works with graduate students to construct a test bank of over 200 items for each introductory course.



A graduate student has one of his lectures videotaped. Later he analyzes it with Susan Shrock of the Office of Instructional Development.

classes each September. Enrollment in the seminar was voluntary; it was not a degree requirement, but Saunders made it clear that future assignments to associate instructor positions would be awarded only to graduates of the course. Conversely, enrollment in the seminar would not assure an appointment. Grading was on a credit/no credit basis.

In the seminar each graduate student prepared and delivered a full-length presentation for subsequent use as a regular session of Econ 103 or 104. Staff members of the University's Office of Instructional Development videotaped each presentation, analyzed the playback, and then met with the fledgling instructor to discuss his or her performance.

"We were sensitive to differences in personal style," says Susan Shrock of that office, "and we stayed away from that issue. We didn't lay a trip on them about their being too informal, for example, or too aggressive or moving too slowly. We used no scale of set standards by which everyone was measured, because they varied widely in approach, and many were perfectly valid. We did identify skills we thought they ought to have, as well as individual traits which might not be productive. In viewing the tapes, we pointed out that, say, the teacher speaks very rapidly, or that he never makes certain that the students are understanding, or that she closes her book with a thump before giving the homework assignment, by which time half the students are out the door."

While the tapings were a prominent feature of the course, there were others. Microteaching was tried, in which brief presentations were made to small groups of colleagues. At one point, the graduate students were asked to respond to dramatized vignettes involving such classics as "the crying student" or "the cheater." Tricks of the trade were revealed—how anecdotes and illustrations clarify points, and how predetermined objectives dictate the preparation of exams.

Another product of the seminar has been student workbooks for both 103 and 104, based upon careful charting of the courses' eight semesters. Their intent is to aid students in understanding precisely what is expected of them and to provide self-study exercises exemplifying the kinds of reasoning demanded. The analytical core is outlined, including (for Micro 103) general concepts such as scarcity, opportunity, cost, and production possibilities curve, then competitive market pricing, price and quantity in competitive and monopolistic firms, and factor markets. Following this are sample multiple-choice and essay questions, as well as homework problems, all designed to define the core.

Learning experience:
Introduction to Microeconomics and Introduction to Macroeconomics. No prerequisites. Enrollment: 5,500 to 6,000 in 80 to 85 sections annually.

Other descriptions:
"Experimental Course Development in Introductory Economics at Indiana University," *The Journal of Economic Education*, Special Issue No. 4, Fall 1975.

Contact:
Phillip Saunders, College of Arts and Sciences, Indiana University, Bloomington, Indiana 47401, (812) 337-2761.

Saunders insists that introductory economics could not have been renovated without the active cooperation of his fellow professors. Still, he must be designated the guiding force. He was fortunate in the circumstances that attended his arrival in Bloomington. He did not have to persuade or impose his notions on the faculty; he was invited there to make changes. That may account for the lack of resistance from administrators and peers.

At the same time, his progress has hardly been hindered by certain other facts: He was appointed as a full professor; he has been appointed associate dean for budget and planning in the College of Arts and Sciences; and he is an accomplished grantsman. At least three research grants have been awarded him since 1970, all directly related to his work in introductory economics, and totaling $74,960. Saunders wryly allows that he finds people increasingly receptive to his ideas.

He is not settling back. He hopes to install student pretesting at the start of the courses to provide a more stable base for future evaluation. The graduate teaching seminar is not yet permanent, and he wants it to be. He is troubled that one quarter of his students find the elementary ideas of economics extremely difficult to master, even now, and he wants to explore new ways of assembling classes that will make it easier both to teach and to learn. ■

The TIPS Phenomenon

What costs around $1 per student per semester, provides highly individualized instruction for large classes, is used in scores of universities and in over a dozen disciplines, and shows the promise of becoming one of the decade's most effective innovations in undergraduate education?

TIPS is the answer, according to research pointing to the success of the Teaching Information Processing System, a computer-managed teaching tool developed by Allen C. Kelley, chairman of Duke University's Department of Economics. Nearly 10 years ago, when Kelley was teaching at the Madison campus of the University of Wisconsin, he received funding to develop TIPS, which employs a computer to provide each student with an individualized course of instruction. This approach can be utilized in most disciplines where subject-matter objectives are reliably measured by well-formulated objective questions. Each semester TIPS is used by over 40,000 students in 16 disciplines, ranging from biology, chemistry, economics, and geology, to history, philosophy, psychology, and sociology.

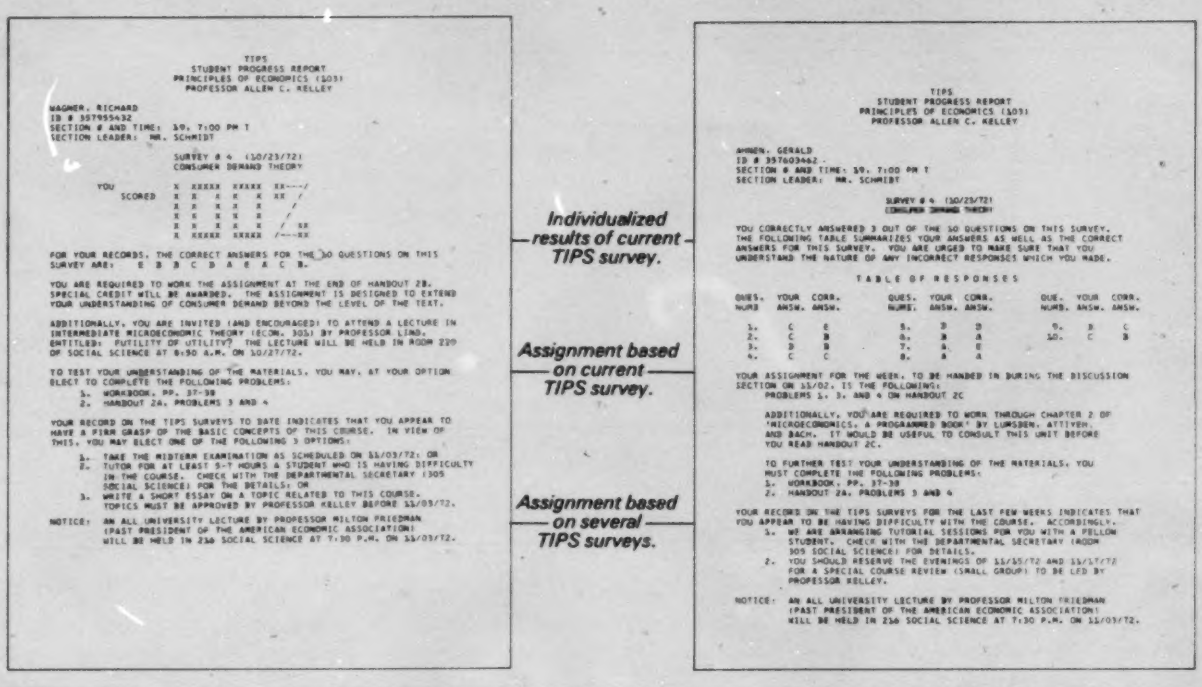
Why TIPS? "Using conventional teaching methods, it is all but impossible for the professor with a large class to know how well his students are doing," says Kelley. "The relatively small number of professor-student contacts fail to give the overall picture. As a result, the professor tends to aim his lectures and assignments at the imaginary 'average' student—and often succeeds in boring the students above that average and confusing those below it. The problem is how to individualize instruction: to teach each student with a level of material geared to his particular requirements, and to reach him in time to do some real good."

How does TIPS work? Every week or so, each student is invited to complete a TIPS survey designed to measure his grasp of basic course concepts. These TIPS surveys, a set of multiple-choice or objective questions that require 10 to 15 minutes to complete, are optional and are not used in formulating course grades.

Results from these surveys are then processed by the computer, which evaluates them against a set of decision rules previously prepared by the course professor. Based on these student data, and on the professor's specially prepared learning prescriptions (assignments), the TIPS computer program generates reports for the professor, his teaching or laboratory assistants, and each student.

The individual student reports are available within a few hours and tell each student precisely how he or she has performed. In addition—and most important—the reports pinpoint weaknesses revealed on the current and earlier surveys, and suggest quite specific assignments through which these deficiencies may be overcome. Moreover, the reports reveal particular student strengths and indicate activities that will advance student learning based on these strengths.

The enormous flexibility that TIPS offers is strikingly revealed by examining just two examples of student reports. Below are reports for a high-achieving student (Richard Wagner) and a low-achieving student (Gerald Ahnen). Note that even by the fourth week of the term Wagner has been identified as doing very well in the course. He is therefore provided the option of writing a paper or tutoring a low-achieving classmate in lieu of taking the examination. In contrast, Ahnen is in ho' water and is so tagged well before the first midterm examination. He is required to take a



TIPS
STUDENT PROGRESS REPORT
PRINCIPLES OF ECONOMICS (103)
PROFESSOR ALLEN C. KELLEY

WAGNER, RICHARD
ID # 357955432
SECTION # AND TIME: 39, 7:00 PM T
SECTION LEADER: MR. SCHMIDT

SURVEY # 4 (10/23/72)
CONSUMER DEMAND THEORY

YOU SCORED

FOR YOUR RECORDS, THE CORRECT ANSWERS FOR THE 30 QUESTIONS ON THIS SURVEY ARE: E B B C D A E A C B.

YOU ARE REQUIRED TO WORK THE ASSIGNMENT AT THE END OF HANDOUT 2B. SPECIAL CREDIT WILL BE AWARDED. THE ASSIGNMENT IS DESIGNED TO EXTEND YOUR UNDERSTANDING OF CONSUMER DEMAND BEYOND THE LEVEL OF THE TEXT.

ADDITIONALLY, YOU ARE INVITED (AND ENCOURAGED) TO ATTEND A LECTURE IN INTERMEDIATE MICROECONOMIC THEORY (ECON. 305) BY PROFESSOR LIND, ENTITLED: 'UTILITY OF UTILITY?' THE LECTURE WILL BE HELD IN ROOM 220 OF SOCIAL SCIENCE AT 8:50 A.M. ON 10/27/72.

TO TEST YOUR UNDERSTANDING OF THE MATERIALS, YOU MAY, AT YOUR OPTION ELECT TO COMPLETE THE FOLLOWING PROBLEMS:
1. WORKBOOK, PP. 37-38
2. HANDOUT 2A, PROBLEMS 3 AND 4

YOUR RECORD ON THE TIPS SURVEYS TO DATE INDICATES THAT YOU APPEAR TO HAVE A FIRM GRASP OF THE BASIC CONCEPTS OF THIS COURSE. IN VIEW OF THIS, YOU MAY ELECT ONE OF THE FOLLOWING 3 OPTIONS:
1. TAKE THE MIDTERM EXAMINATION AS SCHEDULED ON 11/03/72; OR
2. TUTOR FOR AT LEAST 5-7 HOURS A STUDENT WHO IS HAVING DIFFICULTY IN THE COURSE. CHECK WITH THE DEPARTMENTAL SECRETARY (305 SOCIAL SCIENCE) FOR THE DETAILS; OR
3. WRITE A SHORT ESSAY ON A TOPIC RELATED TO THIS COURSE. TOPICS MUST BE APPROVED BY PROFESSOR KELLEY BEFORE 11/03/72.

NOTICE: AN ALL UNIVERSITY LECTURE BY PROFESSOR MILTON FRIEDMAN (PAST PRESIDENT OF THE AMERICAN ECONOMIC ASSOCIATION) WILL BE HELD IN 236 SOCIAL SCIENCE AT 7:30 P.M. ON 11/03/72.

Individualized results of current TIPS survey.

Assignment based on current TIPS survey.

Assignment based on several TIPS surveys.

TIPS
STUDENT PROGRESS REPORT
PRINCIPLES OF ECONOMICS (103)
PROFESSOR ALLEN C. KELLEY

AHNEN, GERALD
ID # 357603462
SECTION # AND TIME: 39, 7:00 PM T
SECTION LEADER: MR. SCHMIDT

SURVEY # 4 (10/23/72)
CONSUMER DEMAND THEORY

YOU CORRECTLY ANSWERED 3 OUT OF THE 30 QUESTIONS ON THIS SURVEY. THE FOLLOWING TABLE SUMMARIZES YOUR ANSWERS AS WELL AS THE CORRECT ANSWERS FOR THIS SURVEY. YOU ARE URGED TO MAKE SURE THAT YOU UNDERSTAND THE NATURE OF ANY INCORRECT RESPONSES WHICH YOU MADE.

TABLE OF RESPONSES

QUES. NUMB.	YOUR ANSW.	CORR. ANSW.	QUES. NUMB.	YOUR ANSW.	CORR. ANSW.	QUE. NUMB.	YOUR ANSW.	CORR. ANSW.
1.	C	E	5.	D	D	9.	D	C
2.	C	D	6.	D	A	10.	C	B
3.	D	B	7.	A	E			
4.	C	C	8.	A	A			

YOUR ASSIGNMENT FOR THE WEEK, TO BE HANDED IN DURING THE DISCUSSION SECTION ON 11/02, IS THE FOLLOWING:
PROBLEMS 1, 3, AND 4 ON HANDOUT 2C

ADDITIONALLY, YOU ARE REQUIRED TO WORK THROUGH CHAPTER 2 OF 'MICROECONOMICS, A PROGRAMMED BOOK' BY LUMSDEN, ATTIYEH, AND BACH. IT WOULD BE USEFUL TO CONSULT THIS UNIT BEFORE YOU READ HANDOUT 2C.

TO FURTHER TEST YOUR UNDERSTANDING OF THE MATERIALS, YOU MUST COMPLETE THE FOLLOWING PROBLEMS:
1. WORKBOOK, PP. 37-38
2. HANDOUT 2A, PROBLEMS 3 AND 4

YOUR RECORD ON THE TIPS SURVEYS FOR THE LAST FEW WEEKS INDICATES THAT YOU APPEAR TO BE HAVING DIFFICULTY WITH THE COURSE. ACCORDINGLY,
1. WE ARE ARRANGING TUTORIAL SESSIONS FOR YOU WITH A FELLOW STUDENT. CHECK WITH THE DEPARTMENTAL SECRETARY (ROOM 305 SOCIAL SCIENCE) FOR DETAILS.
2. YOU SHOULD RESERVE THE EVENINGS OF 11/15/72 AND 11/17/72 FOR A SPECIAL COURSE REVIEW (SMALL GROUP) TO BE LED BY PROFESSOR KELLEY.

NOTICE: AN ALL UNIVERSITY LECTURE BY PROFESSOR MILTON FRIEDMAN (PAST PRESIDENT OF THE AMERICAN ECONOMIC ASSOCIATION) WILL BE HELD IN 236 SOCIAL SCIENCE AT 7:30 P.M. ON 11/03/72.

dose of somewhat remedial exercises, to attend a special review session with the course professor, and to set up an appointment for a one-to-one tutorial with one of his classmates who is doing very well in the course.

A student can only be helped by his participation in TIPS. Should he elect not to take a particular TIPS survey, he is given a standard assignment—one that would normally be assigned to all students if TIPS were not used. The only penalty for nonparticipation is the lost opportunity of receiving an up-to-date indication of course progress, a custom-tailored assignment, and the chance to influence future course emphasis through the feedback received by the professor from the survey results.

The TIPS computer program provides both the professor and his assistants with a variety of summary reports. These display data are useful in appraising the performance of students in discussion sections, laboratories, or in the class as a whole. Using TIPS information, the professor and his assistants can modify their teaching strategy to eliminate weaknesses and capitalize on strengths. By spending less time on concepts that are clearly understood and more on those that are not, scarce lecture, section, and laboratory time can be allocated more effectively.

The key question, of course, is whether TIPS works. After almost a decade of extensive research evaluation, some hard evidence is available on the impact of TIPS. In a carefully controlled study involving over 1,000 economics students, it has been found that:

- TIPS increased student achievement, as measured by course examination scores, by an average of 15 percent.
- The impact of TIPS varied by the type of student. High-achieving students increased their performance by less (around 13 percent), and low-achieving students increased their performance by more (around 19 percent).
- The impact of TIPS on student examination performance was largely unaffected by the type of examination question. Approximately equal gains were registered on multiple-choice, short-answer, applied problem-solving, and essay questions.
- Students displayed no significant hostility to the use of the computer. On the contrary, 54 percent appraised computers as a "significant" educational aid, 32 percent found the system helpful in focusing attention on key concepts and areas of weakness prior to examinations, and a clear majority favored the use of TIPS in future economics classes and in other disciplines as well.
- Curiously, while students' attitudes toward the use of TIPS were strongly favorable, their evaluations of the course and the professor were apparently not influenced by the system. End-of-course evaluations yielded virtually identical results in control and experimental groups.
- The positive impact of TIPS on achievement was retained over time, as measured two years later. This longer retention of knowledge was probably due to changes in study habits engendered by the teaching approach. Students in the TIPS classes have been shown to study and review continuously throughout the semester, allocating a relatively smaller share of their time to preparing for major examinations.
- The proportion of students in the TIPS classes selecting economics as a major, as measured two years later, was 23 percent higher than in the control classes. In view of the fact that the course evaluations showed no evidence that students derived any differential enjoyment from the course or instructor as a result of TIPS, this finding suggests that a student's academic success in a course, rather than his evaluation of it, may be the more important factor in selecting a major.

While the research results and the teaching appeal of TIPS appear to offer a promising solution to some of the more critical teaching problems in higher education, Kelley, an economist, is quick to emphasize that "there is no such thing as a free lunch!" TIPS has costs. These are twofold. First, there are the direct, out-of-pocket costs for typing, mimeographing, computer time, and the like. These costs run between $1 and $2 per student per semester. In many courses, these are only a tiny fraction of the total costs of the course.

The second and more important cost is the start-up time required on the part of the professor who adopts TIPS. The professor must design a "TIPS course," involving the careful specification of course objectives, the formulation or selection of high-quality test items to measure these objectives, and the assembling of learning prescriptions that match the needs of the individual student. It can take an experienced teacher up to a month to develop a TIPS course. Kelley points out, however, that the elements involved in planning a TIPS course are all activities that the concerned teacher should undertake, with or without TIPS, but lamentably often does not. Once this investment has been made, however, subsequent uses of TIPS require a relatively small investment of the professor's time.

As with many teaching innovations, there are not only impacts on the individual student and professor but on the curriculum as well. Kelley pointed out an interesting trend that has occurred across the country where TIPS has been used. "Budget stringencies have necessitated larger and larger classes, much to the distress of students and teachers alike. Unfortunately, the first courses to go are the small-group learning experiences, those 'expensive' elements in the curriculum that often add particular excellence to the teaching program. TIPS has permitted one route to minimize this effect. By using TIPS to 'rationalize' instruction in the lower-division courses through expanding and consolidating classes, faculty resources are released to staff upper-division, smaller classes, even in a situation of contracting faculty sizes."

The TIPS computer program is adaptable to a wide range of computers, and Kelley and his staff are able to provide considerable assistance in facilitating this adaptation. They also conduct several workshops each year for those who are interested in using TIPS. These workshops focus on pedagogical aspects of TIPS, as well as on its mechanics. Some financial support is available to a limited number of schools who adopt TIPS through the Exxon Education Foundation's IMPACT program. Information about TIPS, the IMPACT grant program, and the workshops is available.

For more information: Allen C. Kelley, Educational Systems Project, Box 4747, Duke University, Durham, North Carolina 27706, (919) 684-2723.

MATHEMATICS

TO KNOW IS NOT TO TEACH

by A. B. Willcox

When I emerged from graduate school in the fifties I entered the college teaching community reasonably well trained in the scholarship of mathematics. I knew about as much as a college teacher needs to know about mathematics and about the experiences of learning and creating it. Perhaps because mathematics is closer to pure thought than almost any other discipline, I and most of my fellow graduates began teaching careers with the idea that the essence of good teaching was a lucid and concise exposition of the structure of mathematics. My calling was to lay before the student as clearly as I could the logical chain of ideas that constitutes mathematics, stepping aside at appropriate moments to allow the student to forge links of his or her own. The real thrill of learning mathematics, after all, was a sudden recognition of "the pattern," the discovery of the solution to a puzzle. If one knew mathematics, had experienced the unique thrill of seeing order where there had been disorder, and possessed a reasonably logical mind, then he could teach mathematics.

I must openly acknowledge the widespread reputation of mathematicians as, shall we say, casual teachers. The reputation is largely undeserved. There are outstanding exceptions, and the overall average is better than the myth and rising. But we cannot point altogether with pride. I am convinced that as a PhD of the fifties, I was about average in my concept and technique of teaching. Graduate training in mathematics completely ignored the technique of teaching except insofar as a teaching assistant received positive or negative feedback from his largely unsupervised classroom experience. The graduate learning experience was itself so far removed from the undergraduate educational scene that its contributions to classroom technique were probably negative in the balance. The graduate professor successfully focused his knowledge for an audience of dedicated apprentice scholars. Understandably, his students emerged as teachers with the same focus.

Fortunately, the mathematical community is coming to recognize that good teaching, the art of transmitting knowledge in such a way that it will soak into young minds, is as important as possessing the knowledge itself. Naturally, the first responsibility of the teacher is to be authentic, to be competent in his or her field, but knowledge must be transmitted to live. Mathematics teachers are working harder at their teaching. It is beginning to show. And I am convinced that almost anything they try will work.

Is this heresy? Perhaps, though I hasten to add that not all educational experiments are successful, whatever "success" means in this laboratory. Not all teaching innovations endure and many that do are not transportable. But I find it hard to imagine any serious and carefully planned teaching innovation that will not contribute ultimately to better teaching. Even a teaching experience that is largely negative usually points toward a promising alternative, and I have yet to learn of a teacher who has taught students less during an innovative classroom experience than he or she usually taught in the traditional mode.

The direction of teaching improvements in mathematics in the past few years, as I see it, is primarily toward increasing our students' understanding of the role of mathematics in society. This is a loaded phrase, of course, and I am using it broadly. Mathematics is closely related to the mainstreams of thought. It is vital to man's efforts to understand his physical, intellectual, and social environment and it receives stimulation and direction from these efforts. In the headlong rush of the fifties and sixties to teach our students more and better mathematics, we probably neglected these relationships between mathematics and the real world.

A. B. WILLCOX is the executive director of the Mathematical Association of America.

Mathematics students and the field as a whole suffered. There is a growing awareness of this blind spot, and teachers are rushing to add "relevance" to their repertoire. The teaching projects in this report reflect this trend, but many of the changes are taking place quietly in classrooms where the teaching is still generally considered to be traditional.

There is also a great deal of experimentation with various modes of self-paced instruction as teachers strive for an antidote to the mass marketing of the expansionist sixties. Experimentation with the use of various media in large group instruction is still going on, but these projects too are searching for more personalized instruction.

Mathematics has several important instructional assets that we should not fail to use in our efforts to improve undergraduate teaching. For example, there are few if any strong cultural factors to influence the content and methods of undergraduate mathematics. Mathematics has strong cultural ties but it does not itself espouse controversial theories. The mathematics teacher is therefore free of many of the constraints felt by teachers of, for example, history, sociology, or even biology. We are also fortunate in that mathematicians do not generally specialize at the level of undergraduate study. Almost any reasonably well-trained mathematics teacher is scientifically qualified to teach any undergraduate course; certainly any PhD should be so qualified. For this reason, it is easier to assemble a team of mathematics teachers to experiment with new teaching techniques in a particular subject than it is to assemble such a team in another field. We have a responsibility to use such special assets wisely.

In searching for teaching projects to nominate for this report, we wrote to the directors of several innovative projects that were widely discussed in the late sixties and early seventies. The response might be considered discouraging. A typical reply included the statement, "In spite of initial successes, I notice that many such programs eventually regress toward the old-fashioned prototypes—perhaps for very good reasons." Another person, who has been extremely active and influential in the leadership of the Mathematical Association of America, the organization most directly concerned with undergraduate mathematics teaching in the United States, advised that our efforts to improve the quality of teaching be restricted largely to improving the ability of new PhDs to teach in the traditional mode. He reasoned that most of the innovative teaching projects have very little influence on 95 percent of the teaching. In the end, none of these vintage teaching projects turned out to be suitable for discussion in this report. Discouraging? I think not. This is the normal life cycle of teaching innovation. One might as well be discouraged by the fact that even the great eventually die. The teaching innovation that evolves back to the traditional prototype leaves tradition changed in some way. Few innovative teaching experiences have profound influence on the vast majority, but even the least has some influence. The most radical experiment can teach even the strict traditionalist something useful. Only by continually trying out new ideas can we grow, and if we do not grow, we gradually die.

Good teaching is hard work, and improving teaching even a little takes real effort. Any college teacher who fails to realize this is not fully equipped for our profession. Any college teacher who does not work hard to improve his or her teaching technique neglects one of our primary professional responsibilities. Any college teacher with a vision for better teaching who does not dare to experiment, for fear of failure or out of reluctance to break rank, is wasting one of our most precious national resources. I congratulate the editors of *Change* and the directors of the Undergraduate Teaching Program for providing reports of some of the attempts of our colleagues to grow in their teaching. We will all grow a little from their efforts. □

DEVELOPMENTAL MATH WITH A DIFFERENCE

by L. Steven Zwerling

Palm Beach Junior College (PBJC) looks like dozens of other public two-year colleges of recent vintage. It is a flat Florida expanse of condominium-like offices and classrooms crisscrossed by a network of open-air walkways and landscaped inner courtyards. And at the fringes of the scene, acre upon acre of parking lots.

PBJC resembles other community colleges in other respects as well. A full 25 percent of the entering freshmen have had little or no mathematics in high school. Indeed, half of these students lack the arithmetic skills of sixth graders. Although statewide articulation agreements do not call for college graduates to complete any math whatsoever, PBJC nevertheless has always required students transferring to liberal arts colleges to complete at least a semester-long, three-credit general education math course. And since even general ed math demands some knowledge of arithmetic and algebra, students had to be taught these skills. Otherwise this problem would contribute to the wholesale exodus of students from Palm Beach during their first semester or two—again not at all dissimilar to the nationwide experience of two-year colleges. The traditional lecture approach to remediation didn't seem to be working very well; it only succeeded in helping a small percentage of students.

This was the situation Richard Travis encountered when he arrived at PBJC more than 14 years ago. From his vantage point as a math instructor, he was convinced that the traditional classroom methods would never adequately remedy his students' mathematical problems. He had been involved with self-paced, programmed learning approaches to remediation elsewhere and felt strongly that similar learning modes would work at Palm Beach. But the College was a rather traditional place. As another math instructor remembers: Anything deviating from ancient practices was, to say the least, suspect. And thus to work with self-paced learning in a nonclassroom, laboratory setting, would require an indirect approach.

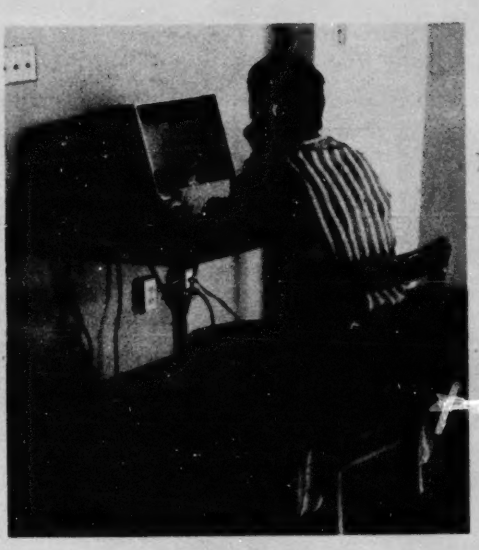
Travis got the mathematics department chairman to allow him to experiment quietly. As far as securing permission from the upper levels of the administration, the philosophy seems best summed up by Travis's attitude to "do it first and then tell them about it afterwards." For two years, then, he ran parallel sections of Developmental Math, teaching one group in the traditional lecture manner while covering the same material with the other section via programmed texts. The results were as he expected: The self-paced students scored dramatically higher on standard exams and completed the work in significantly higher percentages.

It was time to bring the results to the attention of the College's president and his staff, and Travis staged the presentation meticulously. He had carefully gained support for his methods within the department. At first some members were skeptical; most were suspicious of any technological encroachments, even resisting the use of overhead projectors in the classroom. But the data were convincing. In addition, as some now confide, most math instructors were eager to be relieved of the burden of teaching elementary- and high school-level arithmetic. Giving full backing to the program, Ruth Wing, head of the math department, set up a meeting with the president and his academic dean. The entire department attended, giving Travis the unanimous support he needed.

Since that day nearly 10 years ago, the administration has given Travis's efforts its full support. The president of the College for more than 20 years, Harold Manor now says, "What Travis has done is to eliminate the problem of students complaining that 'my math teacher doesn't understand me; my math teacher doesn't explain what the problem is.' It's been so long since I've heard a student complain that he isn't achieving in mathematics. I just never hear a complaint. I'm sold on it."

Early support for the program meant turning a substantial portion of the old library into what was then called the Math Lab (now the Mathematics Learning Center) as well as carving out a slightly larger than usual piece of the budgetary pie to fund the purchase of programmed texts, filmstrip viewers, and tape recorders. In a dramatic move, the College shifted its entire remedial math program into the Math Lab. Travis got what he wanted, but he was also on the spot—what he had done for

L. STEVEN ZWERLING is the director of Circle 72, an alternative learning center at the College of Staten Island. He is the author of Second Best: The Crisis of the Community College (McGraw-Hill).



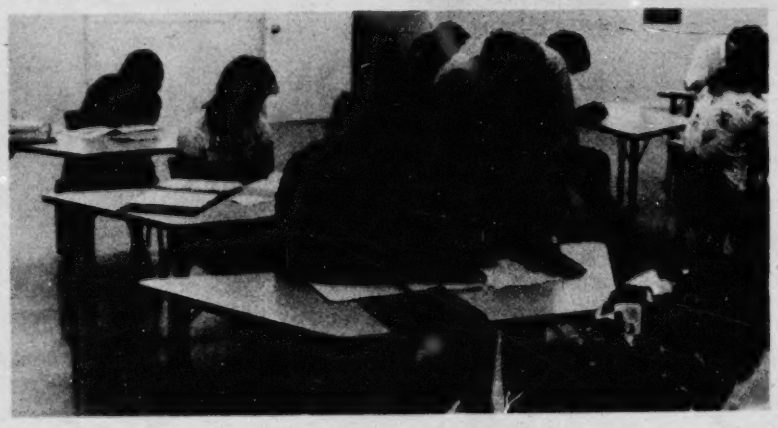
In a nonclassroom, laboratory setting, students in the Math Learning Center study with a variety of materials and seek help from instructors whenever they need it.

a handful of his own students he would now have to do for hundreds, up to a quarter of all entering freshmen taking math. With the cooperation of the department and a carefully chosen Learning Center staff, the task was undertaken.

Students come to the Math Learning Center along three alternative routes: by scoring below the twenty-fifth percentile on the Florida Senior Placement Exam; at their own request (this is particularly true of older students who have been away from school for a number of years); and at the recommendation of teachers of more advanced courses who feel their students were initially misplaced and would benefit by sharpening their skills at the Center.

The Center then diagnostically tests these students and makes suggestions for appropriate placement: one of the three progressively difficult modules of the Developmental Math sequence, General Education Math (for students who plan to transfer to liberal arts colleges), or various more specific math courses that are a required part of PBJC's many two-year career programs. Travis and others at the College stress the importance of student volition at this point in the process. Even if all indications suggest that a student belongs in the first arithmetic module of Developmental Math, he or she still has the option to skip the sequence and go directly to the more difficult courses. The staff of the Center, faculty advisors, and counselors at the College appear to be quite sensitive to the dangers of forcing students into academic tracks that will either brand them as "dummies" or "knuckleheads" (their words) or take away the motivation that results from allowing students to make their own informed academic choices.

The diagnostic tests are designed by the Center staff. They want their students to be placed as precisely as possible within the various math sequences, since they have found that placement at either too low or too high a level of challenge produces frustration and frequent failure. These tests remain available to students during their stay at the Center. As soon as they feel they have mastered the work of a particular unit or module, the appropriate test is administered. In this way students get an immediate reaction to their achievements.



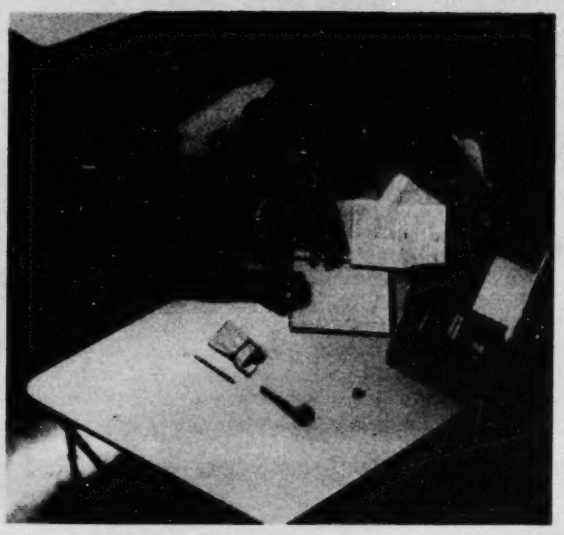
Developmental Math consists of three discrete modules offered exclusively in the Math Center. All instruction is programmed and self-paced. The first module, Basic Arithmetic, reviews and reinforces basic arithmetic principles. The second, Preparatory Algebra, for students with little or no background in algebra, includes work in signed numbers, exponents, and algebraic fractions. The third module, Introduction to Modern Math, is offered in two formats—the first, for liberal arts students, adds work in real numbers to set theory, number structure, and numeration; the second version, for career students, offers additional topics in algebra. Each of the three modules carries one institutional credit (credit that is not transferable but does appear on the transcript). According to Travis, "If a student is going to spend 15 weeks in here, he ought to get something out of it."

Programmed texts constitute the greater part of the instructional material available to Developmental Math students. Module I students use James Smith's *Basic Math*; for Module II, the Center staff has received permission from Encyclopaedia Britannica Press to revise and reprint portions of the out-of-print *Preparing for Algebra*; for Module III, students preparing for General Ed Math use *Modern Elementary Mathematics: A Programmed Instruction* by Todd and McDermott, while students who plan to take more specialized math courses use the two volumes of Alwin and Hackworth's *Algebra: Programmed*. And to provide greater variety, more than 50 different tapes, filmstrips, work texts, and semi-programmed materials are available in the Center. These either supplement the basic texts or provide alternative means of review for students who do not adapt well to learning via textbooks.

But much more than Developmental Math is offered in the Center. From the beginning Travis and his staff refused to set up a remedial ghetto. The College's first offer was to do just that—without, of course, labeling it as such. Travis's own intention, however, was to establish a place where students could learn both developmental math and more advanced material via alternative nonclassroom, nonlecture modes. He, along with Ruth Wing, fought to have students of all ability levels working side by side, and they won. Today, therefore, in the Center at the same time are some students struggling with basic arithmetic while others are grappling with college algebra or trigonometry or technical math—all offered in self-paced form. Again, with these more advanced courses, student choice is emphasized: No one is forced to take courses in either the classroom or programmed manner. The options are there. The possibilities to switch back and forth among the approaches are unlimited. And it is clear that the Center's format is quite popular—about half of the students who take Developmental Math in the Center stay on to take their next course there as well.

It is not that Travis feels that self-paced learning is best for everyone. It is his assertion, however, that the lecture approach isn't best either. No one method is best. His philosophy is disarmingly simple: "Our original purpose was not to replace anything but merely to give the student another option. The whole sense of the Math Learning Center is to provide students with a mode other than the traditional lecture class because maybe they fit that mode better."

Individual conferences with instructors and more informal tutoring sessions go on from early morning until late in the evening. Programmed materials, tapes, filmstrips, and workbooks supplement or provide alternatives to the basic texts.



L. Steven Zwerling

The feeling in the Center—the way students and instructors move about in it—illustrates this underlying philosophy. It occupies the vast space of the old library and, though subdivided into two large rooms and surrounded by balconies, conveys a sense of openness and warmth. During numerous visits from early morning until late into the evening (the Center opens every day at 7 a.m. and closes three nights a week at 10 p.m.), I heard only the sounds of serious work and muted conversations as the students sought the help of either Travis or Kenan Foley or Mary Jane Still, the two instructors who work with him. Travis's office contains a large picture window that overlooks the main work area, and as students walk by rarely do they fail to exchange a wave or smile. The other instructors are just as accessible, either wandering about to look over their students' shoulders or tutoring at their desks. Doors are never closed, and a good deal of teaching seems to get done even while students wait on line for their workbooks.

Students spend five hours per week in the Center (two more than if they elect the lecture approach). But the schedule is as flexible as possible. "Yes, they do have a class," says Travis. "Yes, they are supposed to be here at 8:40 a.m., but if they come at 8:45 or they decide to come at 9:50 or 12 o'clock that day, that's okay too. There's no big deal over it. The whole idea is that they're learning some mathematics."

And the statistics indicate that they are in fact learning more than just "some mathematics." In 1975-76, 737 students used the Center (577 of these took Developmental Math). During that year, 82 percent completed at least one module, 67 percent finished two modules, and 54 percent three modules. (Only 48 of the 737 students withdrew from their courses at the Center and of these 48, 32 withdrew from the College.) Most of those students who do not complete the entire developmental sequence in one year persist into a second year, and eventually 87 percent complete the three modules and go on to the next course. Then in the next appropriate math course, taken either in the Center or the classroom, 80 to 85 percent manage to complete their math requirements. All of this fits rather nicely into the College's overall budget: It costs only $75 more per year for a fulltime equivalent (FTE) student to take a course in the Center than in a traditional math lecture section ($1,600 versus $1,525—the average FTE at the College costs $1,479).

Even more impressive than the numbers is what the students themselves have to say about their experiences in the Center. Very few feel stigmatized by the fact that they're taking Developmental Math. Though one firmly declares himself "a mathematical dunce," Philip Jacques's reaction is more typical: "In a lecture course they just automatically assume you know what they're talking about, whereas in this approach they're constantly reinforcing the major ideas. The repetition is boring; but when I learn from it and know what I'm doing, it gives me a great feeling of self-worth." Many value the self-paced approach for reducing the inevitable competitiveness of lecture-recitation classes. Another student says, "By working at your own pace you don't feel inferior to anyone else or superior to anyone else. I feel better here than if I had to be in a class with superior students and not be able to keep up."

Rodney Vincent is not fully happy with the Center's approach to learning. He believes that "books can't explain to me like a teacher can." More typical, however, is the assertion of a thirty-five-year-old housewife who has been away from school for 10 years: "It's less boring than a class because I can go at my own pace. The three hours go so fast; I don't even take a break." And then there is Mark Ellenbogen, who claims he has learned more in two months in the Center than he was able to get in all of high school: "I was never able to do algebra, but now I can."

> **66** The Learning Center confronts the variety of mathematical backgrounds and attitudes that students bring to college. The Developmental Math Program relies on the effective use of programmed and self-paced materials but at the same time calls for diversity in the educational setting available to today's students.
>
> *Donald L. Kreider, Dartmouth College*

Learning experience:
Math Learning Center: a multimedia center offering mathematics at all levels through college trigonometry. Enrollment: 700 annually for credit.

Other descriptions:
Descriptive format available upon request.

Similar courses:
Many community colleges in Florida and around the country have basic or directed studies programs. Some have learning center concepts. The conceptual approach as well as scope vary.

Contact:
R. L. Travis, Sr., Director, Math Learning Center, Palm Beach Junior College, Lake Worth, Florida 33460, (305) 965-8000 x274.

Of course there are problems—some acknowledged, others less apparent. Travis would like the funds to have a second staff person available in the evenings. Students complain they often give up in frustration while waiting on line for help. They feel that much of the programmed material is boring, and the staff laments that they are continually fighting the repetitious materials. Filmstrips and tape recordings help somewhat, but the inherent limitations of the material are a real problem. And then there is something of an inconsistency in the fact that Palm Beach Junior College offers Developmental Math in only one format—self-paced in the Math Learning Center—whereas their expressed philosophy is that there is no best way to teach math. The Center is founded on the principle of academic diversity.

Now more than nine years old, the Center is a pioneer in the use of programmed instruction. It boasts many well deserved successes, and though it shows its age at times, the spirit remains vital and innovative. Travis and his staff are bursting with new ideas and new possibilities for the Center and the College. They notice evidence of interest in self-paced learning among science instructors at PBJC, and they see their ideas spreading to other two-year schools in Florida and across the nation. After nine years Travis says, "We're only at the beginning." ■

FROM THE CONCRETE TO AN APPRECIATION OF THE ABSTRACT

by Gary MacEoin

Verbal M. Snook has been teaching, studying, living, and dreaming mathematics ever since he graduated from the University of Oregon in 1956. He joined the faculty of Oral Roberts University in Tulsa, Oklahoma, when the University admitted its first undergraduate class in 1965, and he has been chairman of the Department of Mathematical Science for nine years, while continuing nine or more semester hours of undergraduate teaching.

A gentle, introspective person, he sensed early in his career a problem of communication with students. "I wondered why another teacher could get the meaning across, while a similar class failed to comprehend me. That started reflection on the elements involved in communication and led me to conclude that for communication to be complete words must be understood in the context of how the person speaking the words is thinking. It is crucial that the thought modes of the speaker be familiar to the persons with whom he is trying to communicate."

Snook gradually developed the hypothesis that he was a victim of his own knowledge. Mathematics is an abstract science proceeding from a body of explicitly stated assumptions from which are deduced statements or theorems of relationship. While elementary mathematics normally studies numbers and space and produces statements applicable to physical experience, theoretical mathematics often deals with assumptions not drawn from the physical world and requires the ability and habit of thinking in highly abstract terms. The typical American youth arrives at college with a background of concrete experience expressed in visual images. The high school student can achieve adequate grades in mathematics by memorizing formulas and generalizations while never reaching any significant level of abstract thought. This for Snook, who regards mathematics with the reverence an anthropologist bestows on a fragment of the skull of Australopithecus, is a multiple tragedy. The student is denied the excitement and pleasure of intellectual discovery, fails to achieve the level of abstract thought essential to a liberal education, and develops a mental block against mathematics.

Prolonged analysis of the problems he had himself encountered and overcome in his professional training started him on the course of experimentation that was to produce the program now known as Math and Society (M&S), a program centered on those aspects of mathematics that relate to the rational process. "When I reflected on my experience as a graduate student," he says, "I recalled some of the pain caused by thinking of ideas that were completely abstract, ideas where I couldn't find a suitable picture. Most of what went on at the undergraduate level 20 years ago could be sketched, if you were reasonably good with pencil and paper. The issue became acute only for graduate work, and by then it was very difficult to bridge the gap between the way the typical mathematics professor thinks and the way the typical college student thinks."

Assuming that mathematics is a general education requirement for all undergraduates, as it is at Oral Roberts, in principle the professor has various choices. He can revert to the concrete and visual level of the students or he can talk at his level, letting the student take notes to be memorized without being understood. These alternatives were equally unacceptable to Snook, satisfying neither his conception of his function as a teacher nor his understanding of what the student should and could obtain from studying mathematics. Reflection and discussion with colleagues brought the conviction that there had to be a third way, a way Snook describes as follows: "We try to go back to the sophomore level of thought, which I characterize as a concrete level of thought, pick the students up, and continuously tempt them to try their hand at abstract thought. Hopefully, over the course of a semester, we can get students actively involved in abstract thought dealing with mathematical concepts."

Having reached agreement on objectives, the faculty started a search for a textbook. Failing to find a suitable one, they began to design a mathematical experience. It consisted at first of four modules or units of instruction: one on

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number concepts, one on mathematical modeling or applications, one on geometry, and finally one on statistics. These units were developed, each by a different professor, during the 1972-73 academic year, and through modular scheduling, each professor repeatedly taught and revised his unit during the 1973 fall semester. In addition, a professor other than the developer taught and constructively criticized each unit. The process was repeated during the two following semesters, by which time the professors involved had isolated some of the positive values. Specifically, they were using the history of numeration and geometry to display the nature of mathematics as a logical structure that serves man in society as a precise means of communication. They were presenting statistics as a modern-day tool for intelligent decision making. And they were depicting the generality of mathematical models by applying a single concept to the problems of population growth, amortization of home loans, and the purchase of insurance.

They were also aware that they were still a distance from their goal. Some students complained that just when they were getting to understand the approach of one professor, they were switched to a new one, and so on for each module. More basically, Snook and his associates felt that the material needed to be integrated into a whole that would be greater than the sum of its parts. And the need for a textbook remained acute. A student who failed to grasp a concept presented in class had no easy way to go back over the material and figure out the issues involved.

At this point Snook took a sabbatical leave for the 1975 spring semester, his purpose being to study the history of mathematics and evaluate the significant mathematical events in light of both the nature of mathematics and the development of western civilization. He soon detected a parallelism between how we learn mathematics and how mathematics developed. Specific needs motivate the child to learn basic number concepts responding to such questions as, How many? and, How much? These were the original mathematical problems of humans who organized social units for protection, mutual aid, and commerce.

Another point that impressed him greatly was the evidence he assembled to suggest that until quite recently, in historical terms, people were either unable or unwilling to think abstractly. The

Arlene Louise Raisner (center), an undergraduate assistant, coaches students in Math and Society.

Egyptians and Babylonians were good at the practical problems of counting and measuring, but their knowledge of mathematics was not extensive. They did, however, formulate specific number concepts, and that means that a concept is not an abstraction but rather a reality existing somewhere between physical objects and abstractions. "Not all concepts are abstractions," Snook concluded as a result of his historical overview. "Concepts become abstractions only as they assume a reality of their own and become eligible for contemplation and study. The logical conclusion is that the student can best learn to appreciate the nature of mathematics as a study of abstractions by being shown how a concept moves through a progression of steps to full abstraction. That calls for learning mathematical concepts and relationships both in the historical context and the practical context of contemporary society."

On the basis of these reflections, Snook proceeded to develop an integrated, three-credit course to be taught throughout by a single professor. His original intention was that the course should be a required part of the 60 hours of general education needed by all students at Oral Roberts to graduate. This would have meant, however, increasing to 63 hours the general education requirements of students majoring in mathematics or areas requiring statistics. M&S is consequently obligatory only for students in other categories: education, fine arts, liberal arts, theology, and so on—for about 35 percent of Oral Roberts's 3250 undergraduate students.

Arlene Louise Raisner, a mathematics major and a junior, audited the course for the double purpose of equipping herself to mark student papers and to coach students with difficulties. "What most impressed me about M&S is that students at various levels of mathematical knowledge and comprehension can meet it at their own level. It is enriching for beginners where they are, and for the advanced where they are. I had done linear algebra the previous semester, and I found that M&S opened up new perspectives to, and new understanding of, what I had already learned."

M&S as now taught contains eight modules or sections, the first four designed to move the student dialectically from concrete to abstract thought patterns; the second four, to show the value of abstract thought, now assumed to be reasonably well grasped, involving concepts and relationships between concepts. What started as "Outlines" has been expanded into what is in effect a textbook of 256 typed pages duplicated for student use and reference.

An analysis of section one shows the methodology: It starts with two distinct concrete concepts of cardinal numbers, the Egyptian concentrating on the quantitative and relating numbers to specific objects, and the Hebraic stressing a qualitative awareness of frequent repetitions that today would be called a rhythm. A familiar example would be the answer to the question, How many times did the telephone ring? If the question had been

anticipated, one would answer "six times"; if not anticipated, "about five or six times." The former answer came from having counted; the latter, from the respondent's sense of rhythm.

Study of the nature of the distinction between various concepts of the same number leads students to further thought about number concepts, so that they come to understand how their own concepts can be perceived in terms of such other concepts as set or one-to-one correspondence, from which it is a short step to geometric concepts. Many students at first need to be frequently recycled back to concrete situations, each cycle carrying to a slightly higher level of abstraction and continuing slightly longer than the preceding.

Analysis of Babylonian and Egyptian numeration starts with concrete examples, then examines the ideas involved in numeration, and searches for the characteristics desirable in a numeration system to ensure successful communication of number concepts. The groundwork is thus laid for a deeper investigation of the Hindu-Arabic system that will come in section five. Counting returns the student to concrete modes of thought in the next cycle, then brings him back to the abstract by presenting the essence of counting as the establishment of a one-to-one correspondence between a collection having an unknown count and a set of counters provided by a system of numeration and having a known—or easily obtainable—count. The final cycle of section one studies measure, taking it to a level of abstraction that shows counting as a special instance of the general measuring process.

Subsequent chapters follow a similar pattern. By the time the first four sections are completed, the student should understand that mathematics involves abstract thought about numbers, geometric forms, and their interrelationships; that mathematicians actively search for relationships involving both number and geometric concepts; and that mathematics is used to model real-world phenomena.

The next three sections stress the value of abstract thought involving concepts and relationships between concepts. The student is expected by now to realize clearly that mathematics involves concepts resident in the mind, concepts quite distinct from the methods used to express them. Section five applies this idea to the communication of number concepts, reviewing historic efforts to record and communicate number concepts associated with counting, measuring and weighing, and analyzing the metric system as fulfilling the practical requirements that, for an integrated system of measure, all units should be based on a single standard unit; that a systematic method exists for relating all units to the single standard unit; and that all systems of units are interrelated.

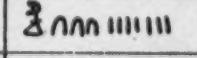
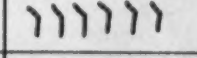
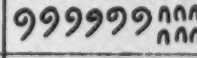
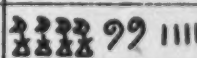
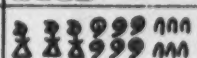
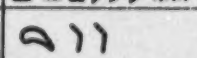
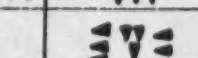
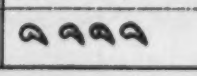
Section six moves deeper into the study of the nature of rational process, presenting conventional topics from symbolic logic from an unconventional point of view. Concepts are developed prerequisite to a "calculus of logic" employing symbols to express increments of thought. The final two sections look at aspects of contemporary society and culture to illustrate the dominant part played by the science of mathematics in formulating and resolving our problems. For a class moving more slowly than projected, one or the other of these may be omitted. One starts with geometry, using Abbott's *Flatland* as a tool to introduce dimension and to open the student's mind to the possibility that three-dimensional space is a subspace of four-dimensional space. Principles that provide for the depiction of three-dimensional objects on a two-dimensional canvas are abstracted to obtain the projective plane. After an optional section involving duality, non-Euclidean geometry is introduced and used to help students understand problems associated with gaining insight into the nature of the universe through inductive examination of evidence.

Statistics closes the course as a subject with applications in almost all areas of life, probably not studied previously by the student, and of such a nature as to permit easy recognition of the abstraction process. Populations and samples from populations of real objects are abstracted to obtain distributions of terms. Characteristics of these distributions are identified and measured, and the resultant information is applied to infer characteristics of the original populations.

No formal tests have yet been developed to confirm that M&S contributes more to intellectual development and acquisition of useful knowledge than

EGYPTIAN NUMBERALS (3000 B.C.)

Number	Symbol	Name
one		staff
ten		heelbone
hundred		scroll
thousand		lotus flower
ten-thousand		pointing finger
hundred-thousand		burbot fish
million		astonished man

MODERN	EGYPTIAN	BABYLONIAN
1,037		
60,000		
666		
4,205		
3,666		
120,000		
400,000		

Diagrams from the study materials depict Egyptian and Babylonian systems of numeration.

traditional introductory courses in mathematics for students who will not specialize in the subject. A test to measure students' attitudes toward mathematics before they took the course was given at the start of the 1976 fall semester. It will be repeated at the end to determine whether a significant attitude change will have been effected. One of Snook's contentions—and student evaluations agree—is that most students have developed a mental block about mathematics before reaching college, the reason for which (he believes) is the gap between the concrete level at which the typical student thinks and the abstract level at which the mathematics teacher addresses his class. He is confident that M&S, by bridging the gap, gives the student more confidence in his or her ability to learn and benefit from mathematics.

Richard Thiessen, a colleague who specializes in mathematics education and who has provided major input in the development of the M&S program, agrees. They both start from the premise that a well-rounded person must be capable of a high level of abstract thinking, that it is possible to reach such a level starting from any academic discipline, but that mathematics by its nature is particularly suited to achieving this objective. They believe that both the study of mathematics and the general intellectual development of young people would be greatly advanced if teachers at all levels became more aware of their students' need for help in developing facility with abstract thought. Just as Louise Raisner sees M&S as capable of being understood at a higher level by advanced students of mathematics than the level of perception of the sophomores for whom it is designed, so Snook and Thiessen think it could profitably be adapted for high school use, and they would gladly cooperate with experimenters in that area. "The gap between the abstract thought level of the teacher and the concrete thought level of the pupil exists, often unrecognized, in grade and high school, too," Snook says. Having taught education majors the required mathematics courses for several years, some receiving the conventional nine hours of content and method and others M&S plus six hours of content and method, he finds the latter group better equipped to meet children where they are intellectually, more aware of the gap, and more expert in bridging it.

While the M&S program would seem in principle applicable in any American college, one factor favoring the experiment at Oral Roberts was that it began early in the life of the college, before graduate programs had started, and that the college's self-identification is primarily a concern with teaching. The mathematics department's most qualified professors were consequently prepared to teach a 12- or 13-hour load, not being under pressures to pursue and publish original research. The department members teaching M&S have voluntarily carried a heavier than normal load in order to keep the classes down to a maximum of 30 students and thus allow for less lecturing and more discussion. Whether classes need necessarily be kept so small is an issue not yet tested, but Snook hopes next year to try a class of 50 or 60 and determine if there will be a significant loss. The consensus of the professors who have taught M&S is that the method needs small classes and lots of interaction. A possible compromise might be to pretest students for level of abstract thinking already reached, then group the more advanced in bigger classes and the others in smaller. The class size is the single possible additional cost of M&S over conventional courses. It calls for no visual aids or other equipment not normally available.

> **66** The ultimate power of mathematics and its continuing value to society reside in its abstractions. But this also provides a barrier to widespread public understanding of the more immediate relevance of mathematics. Math and Society leads students from their comfortable concrete view of the world to an appreciation of the value of abstract thought. The designers of the course may well be right in contending that this removes one of the major mental blocks that closes the door to mathematics for many students.
>
> *Donald L. Kreider, Dartmouth College*

Learning experience:
Math and Society: a general education experience in mathematics. No prerequisite, however the University does require two years of high school mathematics for admission. Enrollment: 350 annually.

Other descriptions:
The following books were helpful in developing the approach:
Bell, E. T. *The Development of Mathematics.* New York: McGraw-Hill, 1945.
Boman, Thorleif. *Hebrew Thought Compared With Greek* (translated by Jules L. Moreau). Philadelphia: Westminster Press, 1960.
Kline, Morris. *Mathematical Thought From Ancient to Modern Times.* New York: Oxford Press, 1972.
Inhelder, Barbel and Piaget, Jean. *The Growth of Logical Thinking From Childhood to Adolescence.* New York: Basic Books, 1958.

Contact:
Verbal Snook, Department of Mathematics, Oral Roberts University, 777 South Lewis, Tulsa, Oklahoma 74102, (918) 492-6161 x254.

A further significant factor in the acceptance of the M&S experiment is the University's self-understanding. An outreach of the Oral Roberts Evangelistic Association, it is a university in the accepted understanding of that word, offering the range of studies at the undergraduate and graduate level one normally finds in institutions of its size. Its catalog, however, reveals an unusually heavy emphasis on theological and biblical studies. There is no separate department of philosophy that might, if it existed, question the propriety of a course such as Math and Society that comes close to performing some of its accepted functions. In addition, there would seem to be a sensed (if not explicitly recognized) need for a discipline that provides some of the intellectual excitement of the philosophical search for ultimates without the threat inherent in philosophy to an agreed system of belief. Conversation with professors and administrators showed a high level of understanding and approval of the M&S experiment. ■

SELF-PACED CALCULUS GROWS UP

by Jerrold K. Footlick

In room 327 of Hamilton College's red brick science building, there is silence, broken only by the occasional slide of a piece of paper or the recrossing of jean-clad legs. In room 320, halfway down the hall, there is sound, a dozen conversations at once, some of them whispered, some louder, some of them confident, some slow and hesitant.

In these two rooms lies the core of the freshman calculus course at Hamilton College and its women's coordinate, Kirkland College, both set in the Adirondack foothills of New York State. The rest of the course is taught in dormitory rooms, in the library, or on the green hillsides—wherever students choose—for they are mostly on their own. The program is called Self-Paced Calculus (SPC). It is one of a growing number of individualized courses offered on the nation's campuses that are generically known as the Personalized System of Instruction. But the absence of a traditional classroom setting does not mean the absence of organization: Hamilton's SPC, now in its fourth year, works because it is a precisely structured program that demands much of its students and encourages, even forces, them to develop the kind of intellectual discipline that a liberal arts education is all about.

JERROLD K. FOOTLICK is a general editor of Newsweek and formerly the magazine's education editor.

The Hamilton SPC was created by two mathematicians, John T. Anderson, the 34-year-old chairman of the College's mathematics department, and Gordon D. Prichett, 35, an associate professor of mathematics who is spending this year on leave at the University of York in England. Two principal concerns led the professors to begin their search for an alternative to the traditional method of teaching calculus. The size of their classes, which they thought should be no more than 15 to 20 students, had climbed to 25 and 30. And they found that the students were exhibiting alarming weaknesses in algebraic and mechanical skills.

Anderson feared that the instructors were losing too many students. "It was frustrating," he says, "to walk into a classroom and know that there were four or five students you were not going to reach. They tuned you out. They were not getting their questions answered in class or even during office hours. They were doomed to failure." On the other hand, if the instructor concentrated overly on the slower students, those who grasped the course more easily would be held back.

Thus the two professors began their experiment with self-pacing. The course could be called informal in the sense that no lectures exist, but there is little that is casual about it. Each student, working with a textbook and study guide, tackles each assignment on his own. A semester's work is divided into 12 units, each of which can—and should—be completed in about a week. For every unit, the student reads the text, works practice exercises, and studies the supplementary guide prepared by Anderson and Prichett. When he needs help, he will usually go first to one of a group of upperclassmen who serve as peer tutors; should he need further assistance, he can go to one of the course instructors. These tutorial sessions take place in a specific two-hour period five times a week—and they are limited to those times.

When a student believes he has mastered the material in a unit, in a single day or five days or whatever, he goes to an office on the third floor of the science building to pick up a quiz. He must

write a perfect quiz; any kind of error, from misunderstanding a problem to transposing numbers, means failure—but there is no grade on any quiz. The quizzes are marked by a student tutor who has been supplied with guidelines of various solutions for the problems, and they are returned immediately. No sooner than the next day, a student who has failed a quiz may take another on the same unit, a quiz that is different but theoretically equal in difficulty.

There is no limit to the number of quizzes that may be taken on a given unit (the record is 10), but it must be passed before the student is credited with completion of that unit. After the completion of the fifth, ninth, and twelfth units, students take proficiency exams to measure their accumulated mastery. These are graded by an instructor and returned the next day. It takes a 90 to pass, but there is no official grade.

Then the student is ready for the final exam. If he has progressed evenly, this will fall at the time of the finals in his other courses. If he has moved faster than average, he will be eligible to take an early final two weeks before the regular exam period. The early final in calculus offers a double bonus: It allows the student more time to devote to other courses during the formal examination period, and the student retains the option of taking the final again during the regular exam period and choosing the better grade.

The course grade depends primarily on the number of units completed, supplemented by the score on the final. For example, a student who has passed quizzes on all 12 units as well as the three proficiencies needs a 96 on the final for an A+ in the course and can make an A- with an 88 on the final. On the other hand, a student who has passed all of the units and proficiencies would receive no worse than a C- in the highly unlikely event that he wrote a totally unacceptable final. A student who does not complete at least nine units is ineligible to take the final and fails the course.

Not many students fail freshman calculus, but all of them taste of failure when they blow a quiz—17 quizzes in 12 units is the fewest ever taken by a single student. "Many of these kids have never failed anything in their whole lives," says Anderson, "but they soon learn that failure has no bad consequences. It just means that they haven't yet mastered the material." For students though, it can be an agonizing lesson. "It's really scary when you fail your first quiz," says one freshman. "You don't know whether to feel humiliated or angry or what. But since everybody else is failing, too, you soon know that this is part of learning."

One potential problem in the self-paced program, of course, is that a student might not know how well he is progressing. The student grapevine works fast, but the information is sometimes faulty. Anderson has solved this in two ways. He hands out a mimeographed schedule for every day of the semester listing where a student should be if he is heading for an early final, is about average, or is slipping toward failure. In addition, he posts an enormous chart on the wall of the tutorial room. Across the top are numbers for each student in the course (about 100 this year) and down the side a number for each unit. As each student passes a unit, a check is placed in the proper box; the chart is updated almost hourly. The system operates anonymously; it is not who passes but how many. For instance, on Wednesday of the fourth week, perhaps four students have already passed five units and the first proficiency examination. Ten others might have passed five units; 20 others four units; perhaps 40 are working on the fourth unit. By looking at the chart, a student knows where he stands in relation to his classmates.

Learning experience:
Calculus and Analytic Geometry (freshman sequence). Prerequisite: four years of high school mathematics or a college precalculus course. Enrollment: 100 to 130.

Other descriptions:
"A Report on Self-Paced Calculus at Hamilton-Kirkland Colleges." Proceedings of the Rocky Mountain Mathematics Consortium, March 1977. Available from Thomas L. Sherman, Arizona State University.

Similar programs:
Many universities have PSI programs or self-paced courses in calculus and other mathematics courses, as well as in other disciplines. Information on the PSI approach is available through the Center for Personalized Instruction, Georgetown University, Washington, D.C. 20057.

Contact:
John T. Anderson, Department of Mathematics, Hamilton College, Clinton, New York 13323, (315) 859-4417.

The SPC program has been installed in three math courses at Hamilton: Math 13 is the first semester and Math 14 the second semester of freshman calculus. Math 15 is essentially a full-year course compressed into one semester for students who have already been introduced to the subject but are not ready for upper-level work. (Some students, of course, enter directly into the sophomore-level math.)

Math 13 covers the areas of limits, continuity, the derivative and its applications, definition of the integral, and exponential functions. Students consider it a conceptual semester. Math 14 continues the study of exponential functions, then goes on to trigonometric functions, techniques of integration, polar coordinates, analytic geometry, and applications of the integral, concluding with the study of sequences and series. It is a mechanical semester.

The textbook is *Calculus—One and Several Variables* by Saturnino L. Salar and Einar Hille. Presumably, almost any of the dozens of calculus texts could be used, but what is essential is melding the supplementary study guide with the text. The guide is divided into five parts for each unit. The first section states the objectives of the unit; the second, procedures, suggests the order of study; the third lists text assignments; and the fourth recommends the exercises in the text to be worked.

The core of each unit in the study guide is section five, the commentary. This is, in effect, the lecture. Written in conjunction with the text, it supplements the textbook with its own sample exercises and demonstrates how they should be worked—just as an instructor in the classroom might use a blackboard. Because the study guide is not a text but rather a lecture, its writing style is informal, conversational, and what Anderson calls talking "to" the students, not "at" them.

Since the written word alone, however, might not be good enough to explain calculus, Anderson and Prichett have provided the human element with a system of peer tutoring. The tutors, who can be sophomores, juniors, or seniors, are not necessarily mathematics majors but students who possess a strong interest and ability in the subject and are personable and articulate. This year's program has 14 tutors for about 100 students. Five to seven of the tutors

are on duty at any given time during the regular afternoon sessions; they work six hours a week for $3 an hour. The tutors have several responsibilities: They hand out quizzes, grade them, and maintain a file of the results. But their most important responsibility is to be available during class hours to offer assistance to students and answer their questions.

> "Self-paced instruction is not new on the educational scene, yet it remains as difficult as ever to administer effectively and imaginatively in the long run. It is encouraging to see a healthy example of self-paced calculus instruction at Hamilton apparently approaching a mature and realistic state that has some chance of a longer life.
>
> *Donald L. Kreider, Dartmouth College*

The tutorial is informal. An instructor may be sipping coffee. Tiny buzzes of conversation are in progress all around. A student may walk up to a tutor and work at his or her desk, or he may signal for the tutor to come to his desk. A question may be cleared up in 20 seconds or 5 minutes. If the student and tutor cannot work out a solution, the student will go to an instructor for further assistance and explanation.

The instructors—two on duty at a time—are in a sense indistinguishable from the tutors. They can answer the easier questions, too, but they are more likely to take the difficult problems and direct a student to deeper exploration. The SPC instructors do not need to prepare lectures, since the commentaries serve that function, but they must continually refresh themselves for a wide range of questions, since students are covering several different units at the same time.

One unexpected problem arose early for the SPC faculty: They enjoyed the one-to-one instruction too much, and so did the students. With students arriving at faculty offices constantly, asking for help and debating problems, consumption of instructors' time got out of hand. Now, no student may consult a faculty member except during the allotted two hours each day when that instructor is on duty. In theory, the same rule applies for tutors, but students are less disturbed about approaching them. "Once you get identified as a tutor," says Michael Marcal, who has served as one for three years, "they will stop you anywhere, in the library, walking across campus, anywhere." He said it with an unperturbed smile.

By now, as the program moves through its fourth year, Anderson and Prichett have cleaned up what they assess as early errors. For example, they once thought it useful to allow a student to watch the tutor grade a quiz. But students used this opportunity for extra tutoring and expected an analysis of every

Mathematics as a Humanistic Endeavor

What is the role of imagination, intuition, or beauty in creating mathematics? How does the creation of mathematics compare with literary or artistic creation? Should it matter to engineering and science students that mathematics is a major cultural force in Western civilization? The traditional mathematics course has a well-defined syllabus of formulas and techniques. Mathematics is, however, more than a collection of facts to be memorized or techniques to be mastered.

Some of these questions and conflicts were presented by Alvin White in a sophomore calculus course that was one of a regular sequence with a traditional syllabus offered at Harvey Mudd College in Claremont, California. To resolve the conflict students were encouraged to integrate the facts, formulas, and techniques with humanistic material concerned with creativity and values. The class started by reading and discussing *Science and Human Values* by Jacob Bronowski, trying to understand, at an appropriate level, his statement, "...the society of scientists is more important than their discoveries. What science has to teach us here is not its techniques but its spirit: the irresistible urge to explore."

As an adaptation of that statement the class was offered a cooperative exam. Each student handed in his or her own paper, but the class was to cooperate in arriving at the solutions. Most students, in fear and disbelief, refused to cooperate.

The second cooperative exam was more successful, and the results exciting. One of the course sections invited another to work out some subtle points on a weekend morning. A student presented his solution to the assembly; it was rejected. Another student offered an idea. There was arguing and some shouting. Finally the correct solution was presented and survived the criticism. This experience was so different from their usual solitary competition that most students were exhilarated. They remarked how much they had learned and how good they felt about themselves and their relationship to the material. The final exam was an individual effort.

The English mathematician G. H. Hardy believed that what distinguished significant from trivial mathematics was beauty. "The mathematician's patterns like the painter's or the poet's must be beautiful; the ideas like the colors or the words must fit together in a harmonious way. Beauty is the first test.... Mathematics must be justified as art if it can be justified at all." Do considerations of beauty and style belong in a mathematics class? Developing a sense of style is an important goal of art and literature. It should be an important goal of mathematics as well.

In an attempt to help the students develop a sense of style, they were exposed to a variety of authors. Instead of one text, about seven calculus texts were assigned. The students were to consult at least two for each topic in a syllabus outline. Homework problems were also selected from at least two texts, in the hope that the differences in approach and notation of the various authors would illustrate different styles. Reconciling the approaches can motivate students to a deeper, more crea-

question. So this time-consuming practice has been eliminated. Anderson also found that logistics were more of a problem than he had anticipated. As the number of students grows, the course needs bigger rooms for tutoring, a more complex filing system for student quizzes, and special rules for distribution of the quizzes to eliminate congestion around the office.

Hamilton's SPC has not undergone formal evaluation, but based on the responses from questionnaires each semester the students both approve the program and benefit from it. Each semester they have been asked such questions as: Are the objectives of each unit clear? Are you able to get tutoring help when you need it? Is the ratio of students to tutors about right? The answers ring mostly positive, but when they tend toward the negative, adjustments can be made. Anderson and Prichett judged it unnecessary to pretest the students since the Hamilton student body is so homogeneous. But except for the first semester, when scores were almost identical, SPC students have consistently scored 5 to 10 points higher on the common final exam than those who took the traditional course. This variance exists even though some SPC students did not reach the final units.

Student interest has also risen. In the first year, only two SPC sections were offered, but now four of the five freshman calculus sections use self-pacing; the College's faculty curriculum committee has required that one traditional section be maintained. Some faculty worry about the additional price: Largely because tutors must be paid, the course costs about $5,500, or $20 per student, an expense worth noticing in a small college at a time of severe budget restraints. After the initial three-year trial, however, SPC has been extended for an additional three years and Anderson feels confident that it will soon become an official part of the Hamilton curriculum.

Anderson believes that self-pacing can work in any course—the physical sciences and psychology are leading examples—but it has not been adopted in other departments at Hamilton. Self-paced courses have had a somewhat erratic record at other colleges, having been tried and dismissed at Williams and MIT, for instance. But there appears to be growing interest. Anderson has been invited to explain his program at various instructional seminars and he is receiving an increasing number of inquiries from colleagues at other institutions.

Two major elements are required to make the program work, Anderson suggests. It requires strong supplementary material, carefully blended with the texts; and it must have a faculty that is interested in teaching students. Hamilton's experience indicates that self-paced calculus works better for students at every level. For the lower group, those who can get lost in the standard classroom setting, self-pacing allows them the opportunity to master the assignments without being confused by a class that is moving faster than they are thinking. The highest achievers can proceed rapidly, unimpeded by slower learners, to tackle fresh challenges. For the bulk of the students, self-pacing may roughly equal the traditional course, but with one momentous advantage—the opportunity to develop a new level of self-discipline. ■

tive understanding. Indeed, although it took extra effort, most students commented that they had learned more from the multiple-text approach. Actually, many teachers consult more than one source, and their lectures are a synthesis of their reading and responding to many sources. The students should have a similar experience.

In addition to assigned homework problems, students were encouraged to invent their own problems. They did not have to be able to solve them—an element of creativity is the boldness to wander beyond the syllabus, to exercise one's curiosity by asking, What if...?

Small changes in the textbook exercises, such as replacing a constant by a variable, made a significant difference in students' ability to solve the problems, especially if they tried to use the methods of the text. Everyone sensed the limits of their knowledge, and it was a revelation to realize that the thick text represented such a thin band of knowledge. The invented problems presented an opportunity to understand the evolution of the subject. Students are seldom aware of the historical development of a problem or of unsolved problems, and the invented problems were given to the class as challenges that some students accepted. They struggled, guessed, reasoned by analogy, and tested tentative solutions.

Class time was spent answering questions, comparing different approaches, and trying to solve or understand the invented problems. Essays by prominent mathematicians and scientists such as Hadamard (*The Psychology of Invention in the Mathematical Field*) and Einstein were also discussed. Students wrote term papers on topics of their choice: essays on creativity, the responsibility of scientists, and fractional integration.

In general, the experiment was a success. Most of the students were enthusiastic. The object was to test a strategy for participatory learning and to integrate the humanistic elements of science with the mathematics of a regular calculus course.

The cooperative exams focused efforts toward achieving a common understanding rather than an individual grade. The multiple texts exposed students to different styles and, one hopes, examples of beauty. The invented problems indicated the limits of knowledge and the evolutionary path of the subject. The readings about mathematics and science gave a context and perspective for the facts and techniques as means, not ends.

There was concern by some students and professors that the regular syllabus would not be covered. The traditional view is that the syllabus is so crowded that adding anything must mean dropping some essential topics. In fact, the regular syllabus was covered easily. Adding that special point of view to the crowded syllabus was like adding sugar to a brimful cup of hot tea—it only sweetened it. Encouraged by the success of the sophomore course, Alvin White is now teaching freshman science students calculus in the context of intellectual history.

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CAN MATH ANXIETY BE CONQUERED?

by Angela Stent

"I can do a job in four hours and Bill can do it in two hours. How long will it take us to do it together?" The somewhat whimsical bearded young man posed this question to a group of 20 Wesleyan students sitting around the blackboard in a light, airy room. Tentative answers began to filter through, and at each stage the instructor asked the students: "How do you feel about this answer?" Some students said they felt good, others said they felt frightened by the fractions. So the instructor drew a large pizza on the blackboard and divided it into pieces to explain fractions.

One student offered his solution: The job will take 80 minutes. Another student disagreed. Three students described different ways of looking at the problem, and the instructor encouraged them to discuss their explanations. Eventually the class agreed that the solution was 80 minutes. One dissenting student admitted that she was upset because she did not really understand how to do the problem. The instructor then spent 15 minutes explaining it to her, while other students tackled new problems with undergraduate tutors.

This class was part of Wesleyan University's Math Anxiety Clinic, one of a number of programs that have sprung up around the country to help those students who are "math anxious." The Wesleyan program offers a unique combination of supportive classes, workshops, a psychology lab, and individual counseling. This concept was developed by Sheila Tobias, a historian and feminist writer, who is the associate provost of Wesleyan, and Robert Rosenbaum, professor of mathematics. "This program was born out of our concern with the absence of women from math classes at the elementary and advanced levels," says Tobias. "I realized that mathematical illiteracy was keeping women from realizing their full academic and vocational potential."

Recent studies highlight her concerns. John Ernest, in his Ford Foundation Study *Mathematics and Sex*, says that from 1972-75 less than 10 percent of the PhDs in mathematics were earned by women. The corresponding figure for comparative literature was more than 25 percent. Lucy Sells, a sociologist currently with the American Sociological Association, shows that in 1973, 57 percent of the men in the Berkeley freshman class had taken four years of high school math, while only 8 percent of the women had done so. This disqualified 92 percent of the entering freshman women from 15 out of 20 possible majors at Berkeley. Sells claims that math is a "critical filter" in the job market and that women who fail to take college math will be excluded from many professions.

Until the age of 12, girls and boys do equally well in math, but after that girls' abilities appear to decline. This may well be because girls are conditioned early to believe that math is unfeminine. Indeed, some female high school counselors, themselves insecure about math, dissuade girls from taking math courses. Ernest's survey of California high school students who received low grades in math tests revealed that boys attributed their poor performance to not working hard enough while girls invariably explained their poor grades by saying that they were no good at math.

Rosenbaum cites another reason for the failure of traditional math teaching—the passive attitude of teachers. "The principal difficulty in elementary schools," he explains, "is that teachers are generalists who either don't enjoy math or don't think they are good at it. By the time students reach high school, math is presented in rule book form, not in terms of the reasons behind certain problems. There should be no dichotomy between the two." At the college level, Rosenbaum says, many mathematics professors think that they have no responsibility to explain basic math. They may lecture well, but they do not teach. Thus the student who has survived high school math by memorizing how to do problems will never really understand why certain formulas are used or how they are derived."

Given their unhappiness with traditional math teaching and the way it affects women, Tobias and Rosenbaum applied to the Fund for the Improvement of Postsecondary Education (FIPSE), which gave them a one-year grant to establish the Math Anxiety Clinic. The Clinic courses began in the fall of 1975 and, after a renewal of the grant for 1976-78, the psychology lab was added.

All Wesleyan students are eligible for the services of the Math Clinic and can apply for the one-semester algebra course taught by the Clinic staff. At

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present 40 women and 30 men are enrolled. (Seventeen students are taking noncredit workshops on topics such as Math for Social Sciences, Word Problems, and Discussion About Math Avoidance.) A diagnostic test of 35 problems determines students' placement in one of the sections, each taught by a different teacher but all using the same book, *Intermediate Algebra* by Johnston and Willis. Throughout the semester the students keep logs describing how they feel about homework, and they have the option of showing these to the instructor or keeping them private. They do up to two hours of homework for each class, and part of each 90-minute session is spent going over the assignments. Classes meet twice a week. Undergraduate tutors give help to individual students.

Classes are based on the principle that there is no such thing as a "wrong" answer, that if a student comes up with an answer different from the one in the back of the book, it is important to decipher what question he or she is asking. Students can opt for a letter grade or a pass/fail; they can repeat tests if they do not do well. There are no more than 20 students per section, and the classes for students who perform worst on the diagnostic test are the smallest.

Jean Smith, who has also been teaching math at Middlesex Community College for many years, teaches the lowest ability section. She sees one of her main tasks as remedying the "school survival strategy," whereby students manage to do relatively well on SATs merely through learning by rote. She disagrees with the conventional view that the only reason for learning math is to solve problems. "I look at math as a reading problem," she explains. In her class of eight students (four males and four females), students read out the problems a few times before they begin to solve them. Her patient attention to any question they raise clearly makes them feel comfortable enough to admit the most basic fears ("I don't understand why, when you multiply fractions, you get a smaller answer than the one you started out with. One half by one half is one quarter, but multiplication is supposed to make things bigger!").

Susan Auslander, who teaches the middle section,criticizes the "math mystique" that prevails in many secondary schools; she is determined to make math a "human" subject. In her class she gently but persistently tried to elicit from students what their real concerns about a particular problem were. She defines success in terms of students gaining a better self-image. "Evaluations from students who took the course last year show that their confidence increased. They still may not love math, but they feel they can work with it and as a result of taking the course, some decided to change their major and take more math."

John Sommers, a 1976 Wesleyan graduate who concentrated on math and psychology, teaches the top-ability math section. He uses somewhat more sophisticated techniques than are used in the other sections, and his problems cover a wider range. Sommers's aim is to ensure that "math is no longer a foreign language for students." He tries to teach math not as an end but a process. His ultimate goal is to encourage students to think analytically. Sommers, who studies and teaches clowning part-time, will offer a workshop, Performing Mathematics, in the spring semester, focusing on magic tricks, riddles, and paradoxes to develop students' mathematical intuition. The diversity and richness of styles in the Wesleyan Math Clinic give students many options. They are exposed to talented teachers ranging from the middle-aged to those in their peer group, and if they are not working well they can move to another section.

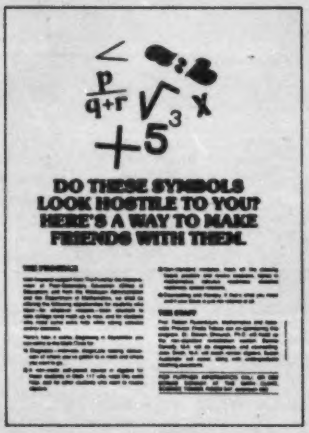
Although classes form the core of the Clinic, counseling has become important since the psychology lab opened in fall of 1976. Bonnie Donady, who was initially trained to deal with students' emotional disturbances, is the lab counselor. Though her math background is not extensive, Donady says she does not suffer from math anxiety. She hopes that the women in the Math Clinic will eventually regard math as a sport—one has to practice in order to do well, but anyone can master it. Donady interviews all students before they enter the Math Clinic, discusses their math history, and usually recommends that they take the algebra course. However, if an undergraduate seems interested in taking the course only because of outside pressure, she may advise that student not to enroll. The important thing, she stresses, is that students take the course because they want to.

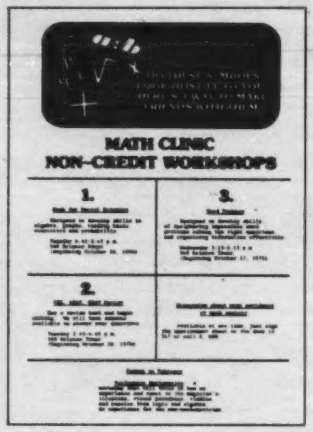
Donady also counsels individual students while they are taking the course. Some see her once a week to discuss their progress. Sometimes the emotional problems they have with math will be symptomatic of broader psychological problems, such as coping with their female identity. Donady visits each math class on a regular basis to discuss with instructors whether they are achieving the right kind of atmosphere for students to ask "dumb" questions. There is constant give and take among all the staff of the Clinic. Group therapy sessions are run jointly by Donady and Stanley Kogelman, a New York-based mathematician and psychiatric social worker. Sometimes students go over specific math problems they have not mastered in class. So far, only 5 students out of the Clinic's fall 1976 enrollment of 70 are involved in the group therapy, but the directors hope that this number will increase.

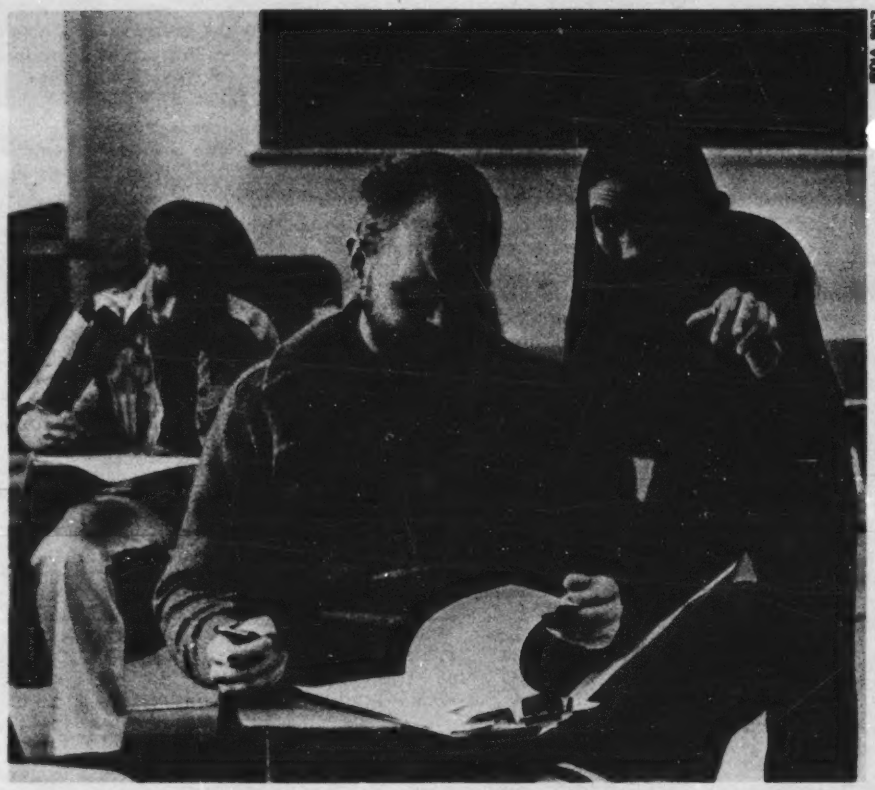
> **66** Mathematical anxiety is a fact of American life, whatever its cause. Wesleyan's Clinic is attempting to reach a wide spectrum of individuals through a dual approach: patient and sympathetic teaching of missing mathematical skills and a direct attack on students' mathematical insecurity. The common goal of such programs is to prevent large numbers of Americans, especially women, from being excluded from careers in science and quantitative fields.
>
> *Donald L. Kreider, Dartmouth College*

Students to whom I talked said they were not interested in taking part in the psychology lab, however. In fact, many admitted that they had taken the course for pragmatic reasons, because they want to do well on their LSATs or GREs, not because they feel an acute need for therapy. Tobias views even these pragmatic reasons as a sign of anxiety.

The Wesleyan Clinic is only in its second year. Last year there were no formal student evaluations, but most individual comments were enthusiastic and showed that students had lost much of their insecurity about their ability to do math. This year, Lorelei Brush of the Wesleyan psychology department and Grace Baruch of the Radcliffe Institute will do a formal evaluation to determine the ex-







Luis Vidal

Susan Auslander teaches the middle section of the Wesleyan Math Anxiety Clinic. At left are examples of the brochures put out by the Wesleyan staff to promote the Clinic's activities.

tent to which students have changed their plans after taking the course. How many who formerly thought they would never take any math courses decide to enroll for another? How many who previously thought they would go into a nonquantitatively oriented field reverse that decision? Before they begin classes and throughout the year, all students taking the math anxiety course are psychologically tested about their math achievements, their attitudes about math, and their general emotional state.

The Brush/Baruch evaluation was derived from their assessment of students in a math program at Wellesley College in Massachusetts, specifically Wellesley's course entitled A Discovery Course in Elementary Mathematics and Its Applications. Although the Wesleyan and Wellesley programs now operate under the same FIPSE grant, they are very different. The Wesleyan program is remedial and traditional in content. The Wellesley course, on the other hand, is not remedial and is experimental. In addition, Wellesley, being an all-female school, can concentrate solely on the problems that women have with math, whereas Wesleyan has close to a 50/50 male/female undergraduate ratio.

Last year the Alfred P. Sloan Foundation funded the Wellesley program and this year FIPSE has given it a two-year grant. Alice Schafer of the Wellesley math department runs the program and four faculty team teach the one-semester course. Unlike the Wesleyan program, Wellesley does not use psychotherapy. "Our course stresses instruction," Schafer explains, "and anxiety is combated by the support of the faculty rather than by psychotherapy. We started off from the standpoint of what we can do to help women broaden their career options by learning math and to show the applications of math to other disciplines."

At Wellesley, students are invited by the staff to take part in the program, whereas at Wesleyan any student can apply to take the Math Clinic classes. The Wellesley staff chooses the students on the basis of SAT scores that show they are capable both in mathematical and verbal skills. However, while all 11 students in the Wellesley course this semester had taken more high school math than one year of geometry and two years of algebra, none had taken calculus and none were planning to take math in their freshman year. Schafer explains that the students were consciously chosen to form a homogeneous group of women who showed considerable promise in math. They are not students with the lowest math ability.

At Wellesley the math seminar, which meets for a total of over four hours a week, is really more of a workshop than a traditional class. The emphasis is on the creative process students go through while learning math. They are encouraged to discover, to think up problems that might be mathematical, and to apply mathematical reasoning to fields such as music and art.

The syllabus is divided into three

parts: The first unit contains no recognizable mathematics, but concentrates on reasoning; the second unit develops algebraic notions by focusing on symmetry in art works such as M. S. Escher's graphics. The third unit focuses on graphs with students charting material from newspapers. There are no letter grades and students do minimal written work but engage in extensive discussion. They work in small groups on term projects such as the one on mathematical patterns of bell ringing made familiar to mystery buffs by Dorothy L. Sayers. Wellesley is also bringing in professional women to discuss how math is involved in such careers as music, psychology, and archaeology.

Last year when Wellesley thought it might have to discontinue team teaching for lack of funds, students in the course circulated a petition demanding that it be retained. Schafer is convinced that Wellesley achieves many of the same results as Wesleyan without using psychology: "Our therapy is showing students that they can do math." There are now 40 math majors out of 1,000 juniors and seniors. As a result of the course some women are now taking joint majors, with math as one branch.

Both the Wesleyan and Wellesley programs share the same goal: to enable students who are anxious about math to build up their self-confidence and possibly choose careers in which they will use math. Both also share the uncertainty of being funded by soft money and not knowing how long they can continue. Wesleyan is in a vulnerable position because none of those who teach in the Math Anxiety Clinic are part of the mathematics department, though cofounder Rosenbaum is a tenured member of that department. While he says that the program has support from the University as a whole, he admits that support may be stronger outside the math department, since some math professors do not regard the teaching of basic or even remedial math as the proper business of a university department. The Wesleyan mathematics department does support a self-paced precalculus course that is taught by the Clinic's faculty. But even if the math department were to absorb the precalculus course, Tobias thinks that there is no commitment to the Clinic itself, and especially its psychological aspects. "My hope is that the math department will absorb the Math Anxiety Clinic," she says. "But I have trouble imagining them having a psychologist on staff."

The Wellesley situation is different, since all those involved in the experimental math program are members of the math department. Schafer therefore has reason to hope that once the grant has expired the math department will absorb the program, but she fears that the popular system of team teaching may be too expensive to maintain. All the instructors this year have been given released time under the FIPSE grant so that they can devote attention to planning and evaluating the course. But once the grant expires, time will cost Wellesley money. Both programs, therefore, face an uncertain future.

The Wesleyan Math Anxiety Clinic and the Wellesley program are clearly making important and innovative contributions. At Wellesley the program is entirely oriented toward the problem of women and math. At Wesleyan, however, with 40 men enrolled in classes, there is some feeling that the course does not provide a comfortable environment for men to voice their insecurities, that it is ultimately easier for women to ask "dumb" questions in class because it is more socially acceptable for women to admit weakness. By a strange irony, therefore, the desire to overcome sex stereotyping in one area may be reinforcing it in another. There is also reason to question whether the Brush/Baruch evaluation originally designed for Wellesley women works equally well for men. Nevertheless, the overwhelming reaction from people I talked to at Wesleyan was positive, and many men obviously felt just as comfortable in class as women. The central point about the Math Clinic is that the students enjoy discovering math.

Programs for students with math avoidance are starting up across the country. MIT and Harvard are experimenting. Mills College in Oakland, California, has a popular precalculus course and a Women in Science program. The latter involves internships for women in industry, drawing on computer and scientific skills, and a program for women to study engineering at nearby Stanford. This year at Mills 650 out of the student body of 850 students are opting for scientific majors, and Mills now faces a shortage of resources to cope with the science boom.

Tobias worries that the truly math-anxious are still avoiding the Wesleyan Clinic. This year, the staff hand-wrote 200 invitations to English and history majors asking them to participate but received no responses. Now they are holding a series of open houses to acquaint nonparticipants with the Clinic's work. Tobias's ultimate aim, however, and one on which she is spending a considerable amount of time, is to encourage the establishment of math clinics for women outside the academic setting. She believes such clinics could be set up in YWCAs. A psychologist and a math teacher (not necessarily a PhD) could conduct sessions during which women would discuss their "math autobiographies" and also study a few specific mathematical problems. Every woman would come away with some positive math experience.

In response to an article she wrote for *Ms.* Magazine, Tobias has received hundreds of letters from women of all ages describing their own terror of math. This confirms her view that there is a vast, untapped group of math-anxious women who can be helped if they will come "out of the closet." She also believes that more research needs to be done both on the correlation among children's play, spatial intuition, and ability to do mathematics, and on the general issue of the use of therapy in higher education. For the moment, however, her main focus is women and mathematics. "My goal is to get women to become aggressive learners," she emphasizes. "They should demand competent teaching as consumers of education. You might say I'm the Ralph Nader of mathematics." ■

Learning experience:
Math Anxiety Clinic. Enrollment: About 200 students have come through the Clinic in three semesters.

Other descriptions:
"Math Anxiety: What It Is and What Can Be Done About It," *Ms.* Magazine, September 1976.
Education Section, News of the Week in Review, *New York Times*, October 3, 1976.
For further information, write for a $3 packet of materials including a detailed description of the Wellesley and Wesleyan programs, a brief bibliography, and a discussion of the experiences thus far.

Similar programs:
Wellesley College (Alice Schafer), Mills College (Lenore Blum).

Contact:
Sheila Tobias, Associate Provost, Wesleyan University, Middletown, Connecticut, (203) 347-9411 x640.

Opting for Computer Aid in Calculus

Even the most dedicated math teacher gets an edge in his voice when a student comes back for the eighth time with the same mistake on the same problem. And even the most determined student's initiative will flag when he feels he has asked more than his quota of "dumb" questions. Some students plow through on their own, some seek help from friends; but high failure rates in college math courses indicate that the resources available to students often are inadequate.

After five years of teaching math at Yale and the University of Minnesota, Leonard Shapiro decided that computers might provide the answer. Impersonal, approachable, and never tired, irritable, or bored, a computer would reassure students plagued with questions. What distinguishes Shapiro's idea from other computer-based teaching programs is his belief that the computer should be used only when the student has trouble with a specific problem, and then only to give enough hints and explanations for him to finish the problem himself.

Three years ago, a grant from the Fund for the Improvement of Post-secondary Education to the University of Minnesota's Consulting Group on Instructional Design gave Shapiro the opportunity to test his hunch. The result was ISCI (Individualized Supplementary Calculus Instruction), a computer program originally written in FORTRAN (and also available in BASIC) that has already been adapted to a wide variety of computer systems.

The operative word in ISCI is "supplementary." Shapiro's program, which encompasses a broad spectrum of problems and will fit into any introductory calculus or precalculus course, is designed specifically to serve as a teaching aid rather than a teaching device. A human teaching aid—a tutor—generally helps the student by doing the problem for him from scratch. ISCI, however, works backwards, exploring the method the student has used to do the problem until the error becomes evident. ISCI is programmed to deal with a wide range of alternate approaches. The computer will provide only the help the student asks for and will never take over and do the problem itself.

ISCI is by no means a very sophisticated error-diagnosis system. It is, however, a simple and efficient method for getting students over the basic stumbling blocks in elementary calculus with a minimum of embarrassment and wasted time. In addition, the system is more cost effective than one that attempts to teach an entire topic by itself, and the simplicity of the program ensures that computer breakdowns and concomitant frustration can be kept to a minimum.

A 1974 study of ISCI at the University of Minnesota showed that the program had a measurable effect among undergraduate users. Although no significant differences in performance between ISCI users and nonusers could be shown, substantially more ISCI users reported that their attitudes toward math were "more favorable" than they had been before. Among students in the lowest quarter of the class, 52 percent ranked ISCI one of the three most helpful resources available to them from a pool including lecture, text, tutors, and recitation sections—a significant pat on the back for the ISCI system, particularly from those students most in need of assistance.

The program has not had much backing from the University of Minnesota, where the math department is strongly research oriented. Although students are provided with manuals, and are free to call up the program on campus computers at their own initiative, its use is no longer formally encouraged in class. Shapiro, however, has disseminated his idea farther afield. The program is on file in the statewide Minnesota computer system, from which students at about three quarters of the state's colleges have been using it on an informal basis. It has also been recently installed on campuses as far apart as the University of Illinois at Chicago Circle and the Open University in Great Britain, where the program made the transition to different computer languages with unusual ease. Shapiro has filled about 100 requests for ISCI materials (free of charge for how-to instructions, $25 for the tape itself), and expects to have more feedback on the program's success very shortly.

How ISCI Works

The dialog below is a sample of what ISCI looks like to a student. The material in italics was typed by the student. (Although single letter responses are used here, words or expressions can be used for multiple-choice responses.) The problem was to find the local maxima and minima of $f(x) = x^4 - 2x^2$.

What problem are you having trouble with?

? MM4

Where was your trouble?
A. I couldn't find F (x).
B. I found the derivative, but I couldn't find the critical points.
C. I found the critical points, but I couldn't determine which were local maxima or minima.
D. I couldn't determine which of the local maxima and minima were absolute maxima and minima.
E. My answers don't agree with the book's answers.
F. I didn't get an answer.

? E

Let's see which one of you has the right answers.

The critical points I found were:
A. 0, 1
B. −1,0,1
C. −1, 1
D. 0, SQRT 2, −SQRT 2
E. My answer does not appear.

? D

There's an error in your solution here. Enter YES for a hint about your error, NO to try the question again.

? YES

Hint: The critical points are the points x such that F (x) = 0, not F (x) = 0. Enter NO to try again, YES to get an explanation of how to answer the question.

? YES

Let's go back a step.
What is F (x)?
A. $x^3 - 2x$
B. $4x^3 - 2x$
C. $4x^3 - 4x$
D. My answer does not appear.

? A

There's an error in your solution here. Enter YES for a hint, NO to try again.

? YES

Remember that the derivative of x^n is nx^{n-1}. Did you forget the n? Enter NO to try again, YES to get an explanation of how to answer the question.

? STOP

For more information: Leonard Shapiro, Visiting Professor, Department of Economics, University of Minnesota, 1035 BA Tower, Minneapolis, MN 55455, (612) 373-4385.

The Classroom at Sperry Univac

"Mathematicians trained in recent years have been given the idea that work on practical problems is demeaning, an occupation for inferior minds," says Wayne Roberts, mathematics professor at Macalester College in St. Paul, Minnesota. "They concentrate on highly abstract courses and remain technically incompetent." So run the charges, and there seems to be enough truth in them to sustain lively debates in mathematics journals.

Roberts and his colleagues wondered how they could make mathematics training more practical at a small liberal arts college. The result is a program that draws on two of Macalester's strong points: the personal attention it offers students due to its small enrollment, and the school's location in a center of industrial research and development.

The program is conducted during the summer. Six participants are placed in local organizations where each works with a research mathematician on a specific project. In selecting students, priority is given to five cooperating colleges in the area. Applicants should have completed their junior year as math majors and some computer programming experience is required. It's been found, however, that local students are more stimulated and self-confident if they are learning along with students from major mathematical centers, so applications are invited from several top schools across the country. Last summer's group included four local participants, one from Yale, and one from the University of Michigan.

"We go after students whose math grades and faculty recommendations indicate that they might be expected to do significant mathematical research," Roberts points out. "Our goal is to acquaint them not only with the work but with the thinking processes of the mathematician working in nonacademic surroundings."

The program was developed in cooperation with mathematicians at industrial and governmental research centers in the area. "We emphasized to them that we wanted to build an educational experience, that this wasn't a veiled effort to find part-time work for our students. In the tradition of private education, we were asking for a contribution: not money, this time, but the attention of their working mathematicians." The department could offer little direct payback except for the stimulation derived from working with an interested student, and the value of drawing budding crackerjack mathematicians to the vocation.

The National Science Foundation (NSF) agreed to fund Roberts's efforts through its Undergraduate Research Participation Program. (NSF subsequently included in its guidelines an invitation to submit proposals involving industrial cooperation.) NSF now provides modest student stipends requiring that the project occupy the student full time. This resolves a question for the cooperating organizations; they needn't worry about whether students are legally regarded as employees, and Roberts feels free to ask that their work be evaluated in terms of educational goals rather than productivity.

Since operations research is not generally covered in the undergraduate mathematics curriculum, the first two weeks of the program are spent in an orientation that includes lectures, literature resources, and a short course in statistics. Most days end with a visit to one of the cooperating organizations where students learn about projects being worked on, see what resources are available (computer, company library, desk space), and ask questions. After orientation, each student spends Monday through Thursday of the next seven weeks with a mathematician, who serves as a work supervisor.

One student worked on a Burlington Northern study to find the most efficient way to spend a $10-million investment in railroad tracks for trains carrying coal from Wyoming. Another worked with the Minnesota Highway Department researchers on a question of controlled-access freeways: how to redesign the computer program to prevent it from closing access when routine slowdowns at curves mistakenly indicate crowding. Other participating organizations include Control Data, Minnesota Mining and Manufacturing, Sperry Univac, the Metropolitan Transit Commission, and the Minnesota Energy Agency.

Each student has an academic supervisor who stops in to make sure the work activities remain consistent with the goals of the program, and to help the student fill academic gaps where necessary. On Fridays participants return to the campus for a continuing seminar on a single area of operations research. They also hear a speaker who discusses at least one of the individual projects. Finally, three students give short talks on their work.

In the last week the student prepares a written technical report and a one-hour presentation about his or her project. One student reported on his efforts at Honeywell to discover if there was a pattern in thermograms that would enable breast cancers to be detected by this heat-photography process. Talks are given to fellow participants, academic supervisors, work supervisors, and sometimes other representatives of the cooperating organizations.

"We had some trouble establishing the program," Roberts notes. "One must get past the Cerberus of public relations and personnel departments to describe the concept to the scientists." The supervision required calls for time, and Roberts has had organizations express their regrets a week before the program starts.

As far as finances go, Roberts observes that while they've been fortunate in securing NSF support, students who participate do lose the opportunity to spend the summer building savings for the school year. The program competes yearly for funding.

Response has been gratifying. Faculty members at the schools to which participants return are full of praise. According to Shizuo Kakutani at Yale, that university's mathematics faculty thinks Macalester conducts one of the finest programs of its kind in the nation. Students themselves are the best boosters. A Hamline student went back to school in September determined to learn more about statistics because in his project at Honeywell he didn't have full command of the statistical techniques he needed. A Macalester student, after spending the summer at General Mills, charged into linear algebra saying, "I wish I'd had this information before." On NSF evaluation forms, students say they had no idea the work of applied mathematicians could be so interesting, that they learned things they never would have come across in courses, and that they'll return to their studies eager to fill in what have suddenly become obvious gaps in their preparation.

For more information: Wayne Roberts, Department of Mathematics, Macalester College, St. Paul, MN 55105, (612) 647-6287.

When Math Takes Advantage of Media

At the State University College at Brockport, New York, the Educational Communications Center provides films, slides, tapes, and all sorts of tools to supplement classroom teaching. Its staff of 12 includes graphics experts, narrators, illustrators, and sound technicians. It was the natural place to turn when Theron Rockhill and Robert Hall wanted a more efficient way to teach calculus to large groups.

"There are three goals in a beginning calculus course," Rockhill says. "We want students to understand the concepts, develop computational skills in differentiation and integration of elementary functions, and relate the skills and concepts to applications in mathematics and related fields. The usual way to teach beginners is in classes of 25 to 30, three times a week. But with several hundred students taking calculus, small classes are impossible to maintain. Instructors and students criticize large lecture groups because not enough material can be covered."

Rockhill and Hall wanted to work out a combination that would include self-study lessons partially controlled by the student—perhaps a system of slides and audio tapes. In the spring of 1972 they asked the Center if anything in its bag of tricks might serve as an alternative to large lectures. They were sent off with a compact audiovisual system—a briefcase-sized portable machine that synchronizes an audio cassette with a super-8 film cassette.

The next step was to pick 15 topics for their Media Assisted Self Study (MASS) program. By winter of 1973, 11 scripts were ready, each replacing a 50-minute lecture. Rockhill and Hall wrote the copy and sketched the visuals, turning to the graphics staff to design the lessons. All art work, filming, and narration was done at the Center.

"MASS puts you in control of your learning situation," declares the instruction booklet given students when they arrive for the first lesson. After making an appointment each student picks up a package at the MASS Center containing cassettes and a guide for one lesson. Each includes a problem, the explanation of a method or proof of a theorem, and exercises. Since audio and visual tracks are separate, the student can stop the sound to work in the guide, study a single frame, or review by rewinding the tape, film, or both. Solutions are given in succeeding frames. As a built-in evaluation system, each student is asked to complete a form, rating the lesson and indicating how much was learned and whether the equipment was difficult to operate.

One MASS lesson per week was the original idea, but faculty and students prefer one every two weeks. "We use them sparingly, just as we would films," Rockhill says with some disappointment. "They've replaced about a quarter of the lectures in the introductory course. It's harder than I thought to wean students from the classroom atmosphere. The combination they seem to like best is limited use of MASS with lectures and small sections."

The lessons run 18 to 35 minutes nonstop, though a student can spend from 20 minutes to more than an hour, depending on how often he or she pauses to backtrack or do exercises. Lessons requiring 30 to 45 minutes to complete, including stops, are the favorites. "I guess this is the dose they're used to," Rockhill says. "Through high school and college their classes have always run about that length."

Professors at Brockport are using the system in interesting ways; even those who don't normally use MASS assign it to students who were absent, didn't understand a lecture, or need to review for courses with a calculus prerequisite. The lightweight plastic machine is often carried to a dorm or hospital room, and Rockhill envisions the day when "the patient in the next bed is amazed to discover that his neighbor is doing math, not getting a transfusion."

Rockhill and Hall plan to write more scripts but "it takes 80 to 100 hours to prepare a lesson. We're in the groove as far as textbooks go, but audiovisual material is much harder. With research, writing, and revision, plus the fact that we have to stay with the graphics people all the way because they're not mathematicians, it's a big project." A college or university without media services would also need to consider cost: The machine runs several hundred dollars, plus the expense of producing the lessons.

Faculty reaction has been mixed. "Some professors feel that chalk and eraser are both necessary and sufficient tools for mathematics instruction," Rockhill laments. "But there's a lot of audiovisual teaching on campus, so the system hasn't been too hard to introduce. Even many of the blackboard traditionalists, once they try it, realize the system is a tremendous help." Some who don't use it regularly give students the option for supplementary work and review. It's not unusual for a professor to remember while having coffee with Rockhill that MASS is available, and adopt it in midstream. One said his class was so pleased that they went back and did the missed lessons on their own.

The instruction booklet reassures the student that "while MASS replaces lectures, it does not replace instructors. Rather, it makes instructors more available to you for small-group instruction and discussions and for individual conferences." Rockhill has found this a big advantage; the system saves him enough time to teach an additional small class in the use of computers in calculus. He's also working on a series of remedial MASS lessons in algebra and precalculus math, and other departments are preparing scripts.

On a questionnaire asking whether they'd recommend introductory calculus with or without MASS, 95 percent of the students voted for it. Comments range from an occasional "I can't learn from a machine" to "Where have you been hiding this?" It's especially popular with veterans and others coming back to school; sometimes they go through all the lessons even before they're assigned.

"We wish you well and hope you find this an enjoyable and profitable learning experience," sings the booklet. Apparently the majority do.

For more information: Theron Rockhill, Department of Mathematics, State University College at Brockport, Brockport, NY 14420, (716) 395-2199.

Trading Rote for Reason in a Heuristics Lab

Last winter Robert Gray, a professor of physics at the University of Massachusetts at Amherst, was visited by a resentful student who had just completed a semester of elementary physics. Her grievance was not her grade: She had received a very respectable B+. The problem was, she angrily explained, that she had understood none of the course. The purpose of her visit was to set up an independent study course in which she could try to understand the material she had supposedly mastered.

A popular myth has it that students fail to grasp physics generally because they are weak in mathematics. Professors at UMass realized that, in fact, the inverse was true as well: An ability to do math and juggle formulas all too often made understanding physics unnecessary. To combat the problem they devised the Heuristics Lab—a teaching resource to supplement the University's elementary calculus-based physics course, developed under a grant from the Fund for the Improvement of Postsecondary Education and now in its second active year.

"In the Heuristics Lab," explains Jack Lochhead, the project director, "we study students' cognitive processes and then use that information to help them become better problem solvers." The Lab, which is open to students some six hours a day, is designed to wean students from the plug-the-variables-into-the-formula school of problem solving. A staff of professors and graduate students who have been specially trained in philosophies of education from Socrates to Piaget force students to concentrate on the learning strategies with which to attack homework problems, rather than on the mathematical tools.

In appearance, the Lab resembles a large, open study hall. Students work on the week's homework problems by themselves or in small groups. Two or three faculty members circulate about the room: The Lab serves also as a place for the instructors to hold office hours. What distinguishes the Lab from a traditional problem-solving session is the quality of the discussion encouraged.

The basic structure of this discussion is simple Socratic dialog. The new feature is that special emphasis is placed on pursuing the consequences of incorrect theories and models. Formulas are relegated to the background, as are the "correct" theories involved. Instead, students are urged to visualize as many models as they can for the problem at hand, to verbalize their thoughts as they go about sifting right from wrong, and to pursue fully the consequences of incorrect theories and models. Often, these incorrect theories are so logically sound that only vigorous classroom debate can pinpoint their flaws. As one student stated, "What are really good are those discussion classes when you argue things out. You get wrong ideas mixed in with the correct ones, and they won't go away unless you think them through." In the course of the debate, students find they suddenly understand concepts that were never confronted in previous math courses where rote memorization had been sufficient.

The teacher's role in these discussions is to encourage debate. If the students themselves do not generate conflicting theories for a phenomenon, then the teacher must offer a few. The teacher must have a genuine interest in exploring the details of the various incorrect models the students propose. Both students and teacher must be willing to free themselves from their stereotyped roles as absorbers and emitter, respectively, of knowledge. Instead, as Piaget advises, they construct a solution to the problem together from scratch.

It's not always easy for faculty members to divorce themselves from their traditional roles. Lochhead reports a "pretty strong hostility" to his program among some of his colleagues, and their opposition has hampered the adoption of the Lab as a regular part of the curriculum. At the University's School of Engineering, on the other hand, several faculty members worked all summer preparing a heuristics lab for an introductory course, and they have had excellent results.

Among students the reaction to the Lab has been almost uniformly favorable. On questionnaires they have hailed the willingness of the staff to discuss points not usually brought up in standard classrooms, like, Where do the electrons go after they light the light bulb? Lochhead recalls two students in the University's prephysics course for disadvantaged students who reported they were baffled by the material. Having failed the course before, they were introduced to the Lab. Both ended the semester with A's.

More formal evaluations of the Lab are impeded by the fact that in most regular courses students seem able to perform perfectly well without understanding what they are doing. It is therefore not surprising—but still disappointing—to the Lab staff that they have so far failed to discover a measurable effect on course grades. They deduce that what they have been trying to teach is in a sense irrelevant to the students' ability to get high grades. "In fact," remarks Lochhead, "the few negative reactions we have had from students are from those cynical but insightful people who see what we teach as unnecessary to their own academic survival."

Yet most student reaction is highly favorable: "The largest value of the Heuristics Lab is its function of directing students' energies at understanding," said one. "Another important function of the Lab is emphasizing mathematics as a tool for understanding physics rather than as a stumbling block. In particular, the Lab staff impressed on me the value of ratio and proportional relationships that made electric circuits, for example, much easier to understand."

"The arguments and the questions the people in the Lab ask make you verbalize your ideas and that makes them clearer," said another. "You can see why they are right or wrong." But perhaps the most encouraging comment was from a student who simply said, "I feel smarter."

For more information: John V. S. Lochhead, Department of Physics and Astronomy, University of Massachusetts, Amherst, MA 01002, (413) 545-0300.

PHILOSOPHY

PHILOSOPHY TEACHING: MORE QUESTIONS THAN ANSWERS

by J. B. Schneewind

A friend of mine remarked some years ago that his philosophy freshmen really only wanted to know the answers to two questions: Is premarital sex all right, and does God exist? He and I agreed, half seriously, that it was a pity to put them to the trouble of reading all those difficult texts when it would be so much simpler just to answer their questions and let them go home.

I recalled this when I was asked to write about problems that come up in teaching philosophy, because it suggests what seems to me to be the central difficulty. Students do come to philosophy classes in the hope of getting answers to big, important questions. They don't—need I say?—ask about sex much these days. But philosophy still means, to the general public, the effort to answer questions about God, or the meaning of life, or how one should act. And because few students, as yet, are exposed to philosophy in high school, few are disabused of their expectations by the time they get to us. I think these expectations affect much of our teaching. We understand the desire to ask such questions; after all, that's what got many of us into philosophy to begin with.

But we've learned that the road to an answer is long and circuitous and difficult and that we ourselves may never arrive. We've perhaps come to think that in this, as in so many other intellectual endeavors, it is the journey that matters, not the arrival. We have come to take a deep satisfaction in the joys of the quest, and as teachers we tend to hold that it is more important for students to learn how to work out answers for themselves than it is for them to have the answers. And so our first problem is to transform the need for an answer into a delight in the search.

Our second problem follows immediately on the first. How can we keep from losing sight of the original desire to investigate sweeping questions about life? Philosophy is a profession now with an apparatus of societies and meetings and journals. This structure is little more than a century old in the English-speaking world, and it's tempting to blame it for the esoteric and technical nature of much present-day philosophical discussion. Yet philosophy has never been as readily accessible even to an educated public as poetry, music, drama, or painting. Literature and the arts present a more accommodating surface, however complex their depths. Plato's early dialogs or Epictetus's discourses may indeed invite the casual reader and tempt him to go further; but he is likely to be as distressed by Plato's later dialogs as by Aristotle's *Metaphysics*. And everyone knows what happened to philosophy when Kant taught it to speak German.

But philosophy's technicalities are not without justification. They represent improvements in the clarity with which questions can be formulated. They embody a broadened understanding of the range of possible answers. They provide an increased grasp of the arguments that need to be considered. If answers to students' big questions are at all to be derived from rational debate, then philosophy's technicalities have a proper place in the curriculum. Our enjoyment of technical ingenuity and skill must be transmitted to our students, but not at the expense of leading them to think that such technicalities replace attention to the questions. The problem is to link the professional's refinements to the inquiries that generated the whole enterprise.

Various aspects of this basic problem come up whenever philosophers discuss specific issues concerning teaching. Take grading, for example. We all want to be able to state clearly the goals of our courses and

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the standards by which students will be judged. There are some kinds of courses, and some aspects or parts of most courses, where this poses no serious problems. Multiple-choice tests have long been in use, and even the so-called "competency-based" way of setting goals and standards can be used for the more mechanical parts of logic or the history of philosophy or some problem-oriented courses. The resistance I find among many of my colleagues to extending the use of this type of evaluation is not due to an irrational preference for incompetency-based modes of judgment but to a fear that these types of tests will not help us assess what most concerns us—the student's growth in ability to handle philosophical issues once the technicalities have been mastered. We teach those objectively testable matters because we want to teach people how to do philosophy. And we're not convinced that anyone knows how to assess that ability, or improvement in it, more reliably than we do now.

In course design as well as in grading, the problem of professional as contrasted with general interests arises. In teaching the history of epistemology and metaphysics, to take a personal example, I have a constant struggle with two concerns—to show how philosophical thinking is involved with other aspects of the cultural and sociopolitical development of a period, and to show that it is specifically *philosophical* thinking that is to be studied. One can profitably spend a whole term on, say, Locke as a philosopher and one could easily spend a whole term on the influence of his writings. The problem is to balance the two. There is never time during the term to do enough of both.

And the problem is not confined to our historical courses. Philosophical issues arise out of all aspects of intellectual and creative endeavor, and philosophers have, or believe we have, something of value to add to students' ability to understand their work in whatever field it may lie. There are philosophies of art, of history, of the physical and biological sciences, and we would like to be able to work with teachers of those subjects and to reach their students. But our own highly specialized training in graduate school and our highly specialized work ever since have succeeded in making it very difficult for us to explain ourselves to the teachers of these other subjects, or for us to understand them, and to benefit from cooperation in planning courses.

There is an urgent need for philosophers to learn how to bring their skill to bear on this wide spectrum of topics, a need deriving in part from the necessity of finding more students for what we have to teach. No philosophy department should think of itself as primarily concerned with its majors, or with those likely to go on to become professional philosophers. We must make ourselves ever more into an actually indispensable part of the education of every undergraduate student. We need to teach ourselves enough of some other discipline to talk intelligently about it with its experts, and then learn how to bring philosophy to bear in terms that make sense to them and do not require them first to become philosophy specialists like ourselves.

It is no easy task, and it is not confined to traditional academic subjects. There are now emerging what have not been evident for many decades: visible and audible requests for professional philosophical assistance coming from many people engaged in very practical work. The rapid growth of interest in medical ethics indicates only the most prominent of these new areas. From ventures at the National Endowment for the Humanities and the National Science Foundation there arise projects on the ethical responsibilities of scientists who make environmental impact statements; on the criteria to be used in decisions on the siting of necessary but unattractive facilities such as refineries, prisons, and airports; or on the value conflicts involved in the large-scale exportation of agricultural technology to Third World countries. Courses on science technology and society are being developed at many universities. There are obvious ways in which philosophical questions arise in these enterprises. Our problem is to find ways of involving ourselves that will enable us to make important contributions precisely because we are trained philosophers.

I have not spoken of technology in the classroom, or of the various forms of experimental teaching that were fashionable a few years ago. No doubt a few slides or films with accompanying sound tracks would liven up many of our lectures, and alterations of the spatial and temporal arrangements for student-teacher interaction can do much to make classroom conversation more thoughtful and effective. But unless one knows what one wants to get out of these rearrangements, one is likely to end up mistaking a livelier class or one that puzzles over an unusually broad range of topics for a class that is really learning more of what should be learned.

It becomes clear, in the end, that there is a major issue about the nature of philosophy at the root of these teaching problems. Is philosophy a subject that should be expected to give guidance to the decisions of everyday life, to the creative work of artists, to the explorations of scientists, or to the policy making of governments? Or is it a more purely reflective subject—an endeavor to capture in concepts the structure of forms of life that take their rise and continue their course independently of what philosophy has to say? The nature of philosophy is itself a philosophical problem, and as with philosophical problems generally, it is easier to raise it than to solve it. There is, however, nothing unfortunate or surprising about the fact that a philosophical question gives rise to many of our questions about the teaching of philosophy. □

STEPS TOWARD ETHICAL MATURITY

by Richard J. Margolis

The study of ethics, an ever-green enterprise as old as the Tree of Knowledge, nicely illustrates a common dilemma in academia today: that of exposing students to the rigors of a useful discipline without at the same time quelling their original enthusiasm for the subject. At Ohio State University Bernard Rosen, a deft and nimble teacher of philosophy, has attempted to resolve the dilemma through an amalgam of ancient pedagogical practices and modern blandishments. Among other things, Rosen divided the class into small, twice-a-week sections where teaching assistants (TAs) get a chance to offer guidance and tender loving care; toned down his lecture style from swift and dramatic to patient and explanatory; and introduced a questionnaire at the start of the course that is designed to get students deeply and personally involved in the mysteries of ethics. The questionnaire is a crucial weapon in Rosen's well-stocked teaching arsenal; I shall return to it in a moment.

The evidence is spotty, but by and large these combined techniques appear to work. Moreover, they can be applied along a fairly broad front of academic course work, in particular wherever students are required to grapple with a set of difficult substantive ideas in order to sharpen their powers of critical thinking.

A successful lesson, if I read Rosen correctly, would end with the student's confessing to himself something similar to what Simmias confessed to Socrates following a typically intense Socratic learning bout: "...I perceive that I was unconsciously talking nonsense." But because classes at Ohio State are rarely geared to Socratic intimacy—the Ethics course last fall attracted nearly 300 enrollees—Rosen has had to look for substitutes. The 10 small sections help, but they do not necessarily engage the students. The questionnaire, on the other hand, plunges them into the course material; it is baptism by philosophical fire.

The questionnaire invites each student to agree or disagree with a series of philosophically shaded assertions; from the answers a student can discover to which of many schools of philosophy he or she tends to subscribe. Rosen uses such questionnaires in all his courses—in Political Thought and Comparative Religion, to mention two others—and they occupy a special place in his teaching timetable. Students spend much of their course time acquiring the critical skills needed to assess their ethical beliefs as revealed through the questionnaire. In the final exam, a take-home paper, they are asked either to support their original position, or else, if they have changed their minds, to argue convincingly for another point of view.

Thus, if all goes well, the student absorbs a fair amount of theory, including a smattering from such master philosophers as Kant and Mill, in ways that relate directly to his own private opinions. He also becomes acquainted with some basic elements of logic—enough, presumably, to get him started on the task of tough-minded analysis. "The key," says Rosen, "is to involve students in what is being taught. Filling out the questionnaire is just the first step in the process."

The 51 "questions" are not frivolous. They bear no resemblance to those quickie magazine quizzes that invite the reader to "Rate Your Sex Appeal" or measure "Your Emotional IQ." Here are some examples taken from the Ethics questionnaire, each a statement with which one can either agree or disagree. (A "can't answer" option is also available.)

1. The only thing that is *worth* pursuing is pleasure.

2. The things of value in our society should be distributed to those who can afford them as a result of their success in competing in our economic system.

3. What makes an action obligatory is that it leads to the greatest good for the greatest number; motives are irrelevant.

4. It may have been that slavery in the U.S. led to more good than bad overall, but it was still wrong to keep slaves.

5. The only motive anyone has in doing anything is to get something for himself. Even when you help others, it's only because it makes you feel good.

6. The only reason it is wrong for a drunken parent to beat a small child to death is that when I hear about it I feel bad.

7. Pleasure has a value independently of the things it may lead to, but so do other things such as friendship, freedom, and peace.

8. Our moral obligations are solely a function of what the majority of the

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persons living in our society suppose are our moral obligations.

9. When you come right down to it, you can't ever really tell whether you are doing the right thing or not in a given situation.

If you agree with the first four assertions, you are probably a hedonistic free-enterpriser who holds both utilitarian and abolitionist principles—though, as questions 3 and 4 suggest, the two principles sometimes contradict each other. (Rosen tells his students they must learn to recognize their inconsistencies and deal with them!) If you endorse the fifth statement, then you may lean toward "psychological egoism," a term Rosen felt compelled to use in order to account for a large body of student opinion. Earlier questionnaires, which failed to include statements about egoism, drew complaints from students. The omission, they told Rosen, forced them to choose from a set of equally unacceptable opinions.

It is characteristic of Rosen to shape theory to everyday reality. Some of his colleagues in the philosophy department have chafed him for making too much of egoism, an uncertified belief, as if there existed somewhere a philosophical Hall of Fame from which all but the most venerated ideas were barred. But Rosen argues that a teacher must begin where the student is, not where the student ought to be, and if the name of the game is egoism, then Rosen will make the most of it. As he notes in his soon to be published textbook, *Strategies of Normative Ethics* (Houghton-Mifflin), "Egoism is often the first view persons adopt when they consciously attempt to formulate an ethical theory. It is tempting to say the right thing to do is what increases my own good...."

It was Henry Adams who remarked that "what one knows in youth is of little moment; they know enough who know how to learn." Rosen, in concurring with the latter half of Adams's comment, has in effect altered the first half to read: What one knows in youth is of great moment—to youth. The beauty of an idea is in the eye of the possessor.

Even so, both Rosen and the TAs encounter a fair amount of resistance from students who insist that it is possible, even preferable, to live one's life without subscribing to any clear-cut ethical opinions. "It's part of the romantic trend," says Rosen. "Lots of kids hate to analyze; they would rather just 'talk' philosophy in a bull session than actually 'do' philosophy. My task is to engage them in ethics—to convince them that they are as guilty as I am."

One student wrote Rosen a stern note in which he defended philosophical waffling. "Perhaps," he wrote, "I have a moral theory that all of the moral theories are somewhat right. In that case I'm not inconsistent at all, but just annoyed because you accuse everyone who was inconsistent of faulty judgment." Rosen replied with a longish memo that he distributed to the class. In it he said, "One of the many foolish 'consistencies' someone can adopt is always to hold to an inconsistent pair of theories or claims. You may wish to suspend judgment or to give them all up...but when we understand what an inconsistency is, none of us wishes to continue to be burdened with it."

Another form of resistance comes from students who expect to be told what to believe. "They are empty vessels," says Rosen. "They want us to fill them with Truth." It is a shock to many of these students to discover that the course is aimed less at truth than at its hot pursuit, and that the chase is paved with tricky and unfamiliar abstractions. Old, reliable student gambits, such as rote memorization and last-minute cram sessions, are of little use here; only thinking suffices.

Nevertheless, there are surprisingly few dropouts, and doubtless one of the reasons is Rosen's style of lecturing. An associate professor, Rosen has been teaching at Ohio State since 1963, and everyone I have talked to there (including Rosen) agrees that on stage he is a peerless performer. "But I've had to rein myself in," he says. "I found I was entertaining them—making them laugh and making them cry—but they weren't learning."

Nowadays Rosen, who gives three Ethics lectures a week, delivers his message in small, easily digested doses, with many pauses for questions and clarifications. If his talk remains bright and good-humored, it is no longer dazzling. "I'm a patient man," he says. "I try to remember how it feels to be a student—what it's like not to know."

The lecture I attended one Wednesday noon in Sullivant auditorium was, students later assured me, reasonably representative of Rosen's style. He appeared onstage wearing a striped, open-neck shirt, baggy brown pants, and scuffed shoes. Standing there on the huge platform, peering alertly at the audience through horn-rimmed glasses, Rosen looked both small and amiable.

His opening remarks concerned the first assigned paper, a difficult exercise in ethical criticism of an intentionally absurd, male chauvinist proposition, to wit: "There is one and only one rule of moral obligation, and it is the following direct rule: *If any action results in a net gain of the number of males in relation to females, then that action is right.*" Students had gotten their papers back the day before, amid much grumbling and disappointment. Apparently they had not yet solved the intricacies of philosophical criticism, but Rosen chose to be reassuring. The papers, he said, were "promising." The students had not been expected to see all the problems, and therefore they would not be graded on this first paper. "So," he concluded, "things did not go badly."

Rosen devoted the rest of the hour to utilitarianism, "a theory 22 percent of you are inclined to hold." Using an over-

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66 In provoking his resistant students to examine whether the unexamined life is worth living, Rosen succeeds in the philosophical enterprise whatever their answers. His questionnaires elicit an investment with a reckoning due at the end of the term. Something of the student's own is now at stake.

But there is a sociological misconception: Although analysis may knock the edges off a simplistic view, it is wrong to claim that ' [philosophical] analysis makes moderates of us all.' The Socratic tradition of standing, against the state, in favor of immoderate positions is alive in philosophy departments around the world.

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Learning experience:
Ethics. No prerequisites. Enrollment: 300.

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head projector to scribble his main points, Rosen drew a connection between utilitarianism and various theories of distributive justice. He pointed out, for example, that utilitarian modes tended to conflict with the pure form of communism, and he reminded students that more than half of them had endorsed communism in the questionnaire. "Things of value should be distributed to each individual according to need, and we should receive from each individual according to that person's abilities." "Can't you see the headline in the Columbus *Dispatch*?" asked Rosen. "Fifty-Two Percent of OSU Students Are Communists!"

On the whole that day the going was tough but not without headway. Rosen stopped eight times to solicit questions, and if some of the inquiries seemed rudimentary ("Are we talking about utilitarianism?"), others suggested the beginnings of understanding. Rosen remained at all times genial, proffering face-savers to students who were in over their heads ("Perhaps you'd like to think some more about that and see me later."), and passing out compliments whenever remotely appropriate ("You see very well what the game is."). Nobody talked to his neighbor; nobody yawned. Still, in such a big class, and in one presided over by such a strong personality, few students seemed willing to call attention to themselves by asking questions or challenging Rosen. They preferred the safety of anonymity, a common sanctuary at big universities.

It is in the small TA sessions that reticent students get a chance to speak their minds. The day I visited Ed Turnbull's section, for instance, there was a good deal of discussion about President Ford's pardon of Richard Nixon. Students in all sections had been asked the previous week to "state whether you think Ford did the right thing in pardoning Nixon," and to "present your reasons." It was another effort to involve students personally in the process of ethical study. Now, Turnbull took matters a step further by dividing his class into two groups—those who favored the pardon and those who opposed it—and requiring each to discuss how best it might defend its position. (Two out of every three in this particular section opposed the pardon; but in the overall class, I was told, the division was about even.)

The idea was for each group to try to anticipate the other's argument, to frame a suitable response, and then to anticipate the rebuttal, ad infinitum, or at least until the bell rang. Turnbull, a young graduate student with a dark moustache and a concerned look, shuttled between factions, coaching and coaxing. Some of the dialog may be worth citing; it suggests both the gentleness of the process and also a certain pedagogical relentlessness which I take to be a hallmark of Ethics 130. At one point discussion among the antipardoners turned on an assertion that the pardon had "weakened respect for law and order."

> Turnbull: Well, what would the other side say to that?
>
> Student 1: They might say that the President is different. He's on a pedestal. He should be judged by different standards.
>
> Turnbull: All right. How would you respond to that?
>
> Student 2 (after a long group silence): The President should set an example.
>
> Student 3: He swore to uphold the Constitution, and the Constitution says that all men are created equal.
>
> (That wasn't exactly correct, but Turnbull let it pass.)
>
> Turnbull: So?
>
> Student 3: So the President is equal under the law.
>
> Turnbull: Okay. But you haven't proved that the pardon is wrong—only that this particular line of argument is wrong. Let's try another....

Turnbull ended the session by urging students who felt they needed help to

Flexibility and Freedom in the Short Course

If part of a philosopher's job is to see the same phenomenon in different ways, then perhaps that explains why William Blizek questioned the usual practice of teaching a subject in 45 fifty-minute class sessions. He reasoned that philosophy might best be studied with fewer but more intense classes interspersed with periods of independent study to give students time to think things through. In the fall of 1970, he was given the go-ahead from his dean at the University of Nebraska at Omaha to teach his "short course"—one that would last a whole semester but have only 10 formal class meetings.

"What I wanted to do," he explains, "was combine the traditional modes of teaching—lecture, discussion, and independent study—so that the advantages of each would compensate for the shortcomings of the others." There are six weeks of reading and discussion, then six lectures over two weeks, then a six-week period during which each student works on a paper with the professor's help.

The class meets twice early in the reading stage. At the first meeting the instructor explains the course. At the next meeting, students are divided into study groups of five or six students who work together through the semester. Groups meet as often as they like. "They can chew on material without the pressure of an instructor looking over their shoulders," Blizek says. "Students seem to gain confidence from the meetings."

The purpose of this phase is for students to become thoroughly familiar with the material so they can get the most out of the lectures and be well equipped to prepare their papers. They're given a textbook and a study guide of more than 200 short-answer and discussion questions.

Blizek likes to keep in touch with each group through one of its members to make sure things run smoothly. Reassignments to other groups are made when necessary, but group participation is not required; Blizek believes that while groups are helpful for most, some students work best on their own. The reading period ends with an exam, and Blizek goes over the material with each group beforehand.

Next are the six lectures, "where we put the pieces together," Blizek explains. "They're intended to serve as an example of the kind of investigation we expect students to do in their papers." For Philosophy of Justice, Blizek spent the first five lectures on John Rawls's theory of justice. For the sixth he brought in a colleague to criticize Rawls's ideas. While in some short courses the lectures have covered different topics, this method had interesting results. Blizek reports that "I'm always amazed during the sixth lecture at how well students know their stuff. They argue with the lecturer, passionately defending Rawls. They use what they've learned confidently."

In the third phase each student writes a 10-page paper analyzing the

call on him in his office. He not only repeated his office hours, he also gave out his home telephone number. "Lots of them need one-to-one instruction," he said to me later. "I just hope they call me." If Ohio State is a "diploma mill," some of its teachers grind exceeding fine.

It can be seen from all this that Rosen and his TAs rely heavily on the tried-and-true—on such traditional teaching virtues as patience, courtesy, and day-to-day doggedness. And the questionnaire, that novel enzyme in the academic mix, appears to create a new chemistry, or ambience, in which the student stands a better chance to learn. The payoff comes when and if the student changes—not his views, necessarily, but certainly his arguments and his way of examining ethical issues.

I did not see the final papers that students wrote for Ethics 130, in which they attempted to demonstrate their progress, but I did get a look at about 50 final essays written last spring for Rosen's course on Political Thought; and, because that course is taught along lines similar to those followed in Ethics—with students starting out by answering a questionnaire about their political beliefs—the papers were revealing. What they revealed, mainly, was a tendency toward pragmatism; or, better still, a drift toward a stronger sense of consequences. In paper after paper students noted that their initial beliefs had turned out to be "impractical" or "unworkable." One student wrote that at the outset she had claimed the only purpose of government was to prevent civil unrest, and that all governments ought to be judged against that single standard. "I now see," she observed in her final paper, "that the putting down of civil unrest could be brought about in circumstances that I wouldn't want in my society." Similarly, a student who began by endorsing voter intelligence tests as a measure for enfranchisement ended by conceding that "I no longer find this solution acceptable."

True, these were not earthshaking transformations, but they were present in nearly all the essays I read, and they seemed to reflect genuine learning, a process that is less a great leap forward than it is a sequence of small, tentative steps toward the light. What these papers suggested to me was that the students' new familiarity with the tools and uses of critical thinking tended to encourage reconsideration of extreme positions. In the American context, at least, analysis makes moderates of us all. (These are my ideas, and possibly not Rosen's.)

So it may be that Rosen's courses are ways of speeding freshmen and sophomores toward what we adults are pleased to call "intellectual maturity"—a state of mind that shrewdly examines the ideas set before it, and one that does not yield readily to foolish argument. Such rational heights are not easily attained; few of us, caught as we are in the swirl of ideas and events, manage to stay on top for very long. Yet in a society that depends for its strength upon free citizens who must be prepared to make difficult moral choices, the game of tough-minded analysis is definitely worth the candle.

As for the students, they have every reason to resist Rosen's assault on their romantic vision; for ethical criticism, like other disciplines, seems at first to narrow one's possibilities and to confine one's spirit. Most students would probably agree with Dostoevsky's Underground Man, who asked, "What have I to do with the laws of Nature, or with arithmetic, when all the time those laws and the formula that twice two make four do not meet with my acceptance?" It is only later, if ever, that students come to grasp the broader possibilities that derive from mastery of complex ideas, and to find therein the seeds of their own intellectual emancipation. Rosen's approach, it seems to me, takes this often painful process a step or two beyond the ordinary. ■

philosophical question of his choice and suggesting a solution and supporting arguments. Students may meet with the instructor as often as they think necessary. Blizek recommends a minimum of three conferences: to discuss the topic, check an outline, and go over a rough draft.

During spring and fall 1971, the psychology department studied the short course in comparison with a conventional one. They concluded that highly motivated people did best in the short course and were most satisfied with it, indicating that the method is probably most suitable for philosophy majors, honors classes, and graduate students. But the study also showed that students in general preferred the format and retained more information. Poorly motivated students weren't as successful, but, Blizek observes, "This should improve. The short course has been modified since the experiment and I think another evaluation would show more favorable results."

One of the merits of the format, Blizek believes, is that it leaves extra time that the instructor can devote to the course. "When a semester includes 45 lectures, some are for background, some are hastily prepared because the professor is concentrating on his research, and still others have been given every semester for 20 years. But in the short course students are so well prepared after the reading period that the lecturer can go into much more subtle and complex material."

The program has drawn a variety of reactions from faculty. "Most professors have been unwilling to try it," Blizek reports. "I get the impression they're threatened by a structure that deviates so from the usual, that they would feel guilty about a format that leaves them so much free time." He goes on to say that some instructors are not pleased with attitudes students display after a short course. "Students are expected to have a certain body of information and it's not always acceptable for them to go beyond that, to press questions too far." On the other hand, some praise just this point: Another philosophy professor who taught Blizek's former students mentioned that they asked questions more freely, showed broader thinking, and were more prepared to delve deeply into issues.

Most students are delighted with the program. Some have complained that conventional courses are dull and slow in comparison, lacking the flexibility and freedom of the short course. "There's no question that the course draws well," Blizek says. "At first we had all of 25 students, and last time there were two sections of 35 each. The short course inspires the kind of thinking that leads to imaginative and creative philosophizing, and isn't that what we're here for?"

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PHILOSOPHY MIXES WITH TECHNOLOGY

by Charles J. Sugnet

Milwaukee, often called "the machine shop of America," is the logical place for a program concerned with the impact of technology. And it is a doubly appropriate place for Carl Hedman's contribution to the program: Philosophy 338, Perspectives on the Philosophy of Technology—Contemporary Decentralization. The program in Cultural and Technological Studies (CTS) at the University of Wisconsin at Milwaukee (UWM) grew out of a belief among some engineering professors that the usual smorgasbord approach to humanities requirements was not serving their students well. They believed that their students needed an opportunity to consider engineering in the broad context of culture and values, rather than just a finishing-school smattering of a "culture" that presented itself as the opposite of engineering.

The program they initiated quickly gained the support of faculty in other areas. Funded by the National Endowment for the Humanities and the Sloan Foundation and generously supported by the University itself, that program is now in its fourth year and seems likely to survive in spite of the heavy pressure always put on interdisciplinary programs in periods of budgetary stress. The program has retained its engineering clientele but has achieved a much broader base so that only about 40 percent of its current students are in engineering.

Faculty are appointed 50 percent in the program and 50 percent in standard departments, with the program handling merit increases for the first several years of the appointment. Courses are cross-listed under both the department and the program, and the resulting gain in enrollment has helped some departments. Core faculty in the program are extremely varied, including a specialist in the history of the Army Corps of Engineers and the ex-curator of a West Coast poetry archive, as well as more conventional professors of history, literature, engineering, anthropology, philosophy, and urban affairs. And the courses are just as varied and interesting as the faculty: Frankenstein Revisited: Bioethics and the Future of Man, taught by a zoologist and a comparative literature specialist; New Utopias: The Mystique of Systems Design, taught by an urban affairs professor; Social History of American Technology, by a historian; and Art, Literature, and Technology, by an English professor.

The booklet listing these courses includes extensive reading lists for each, and merely reading it was illuminating; several courses looked interesting enough so that I wished I could stay in Milwaukee long enough to take them. Talking to various staff members convinced me that the program was functioning in the way interdisciplinary programs are supposed to function and was addressing important issues in a fashion that transcended the ordinary perspectives of the individual disciplines involved. Some of my own academic work took on added significance as a result of the discussions.

UWM is largely an urban, commuter school, and many of the students in Carl Hedman's Perspectives on the Philosophy of Technology course work shifts in the factories, so they can speak firsthand about the human costs of centralization and standardization. However, much of Milwaukee's heavy industry remains small (machine shops, foundries with fewer than 50 employees), so that the

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students have before them working models for the conduct of small-scale enterprises and are likely to have relatives or close friends who are employed in such enterprises.

Contemporary Decentralization enrolls 40 to 60 students and meets one evening a week for two to three hours. The first hour is devoted to theory and consists of lecture and discussion based on the assigned readings, which all deal in some way with questions of technology and scale: Schumacher's *Small Is Beautiful*, Heilbroner's *An Inquiry Into the Human Prospect*, Vanek's *The Participatory Democracy*, and Illich's *Tools for Conviviality*. In some way or other, all of these books demonstrate that our present social arrangements are unsatisfactory, that we are wasting fuels that will soon run out, that we are committed to an insane economic growth that will soon bring us into conflict with other nations over scarce resources, that the large-scale institutions we create to serve our needs reduce us to passive dependency, creating more need in turn.

Hedman is very colorful and passionate about his beliefs, though in a gentle, low-key way. He supplements the readings with a large number of dittoed handouts describing successful worker-managed cooperative enterprises. In class sessions he lays out the reasons for moving to smaller scale in at least some aspects of industrialized civilizations and holds up possible models for decentralization. There are also visiting lecturers, such as the anarchist Karl Hess, or local lawyers who explain the complications of incorporating a cooperative business.

Up to this point, Philosophy 338 looks like many courses—its subject perhaps a bit unusual for a philosophy department, but its format familiar. However, Hedman is very serious about decentralization as a process, not just as subject matter, and he sees that it implies a critique of education itself. For him, it would be hypocritical, self-contradictory, and futile to conduct a course in decentralization that relied on a centralist model for education, a model analogous to the wholesale distribution of goods, in which the professor has final knowledge and distributes it to students who absorb it passively and remain separate from each other, relating only as so many atomic units directly to the central authority. Instead, he encourages the students to work cooperatively, to learn from each other without the mediation of the instructor, and to move from theory to practice by setting up practical enterprises of their own. Thus, the heart of the course, and the thing that distinguishes it from others with similar subject matter, is the formation of small study groups that meet together during the second half of each week's class.

Everyone in the course fills out a questionnaire, and on the basis of responses students with similar interests are put together in groups of 5 to 10; groupings are voluntary, and there is usually some movement from group to group during the first weeks of the course. Each group must produce a cooperative project; some work on relatively traditional research (such as survey and analysis of the potential sources of capital for founding a new worker-owned business), but others work toward a specific manufacturing proposal. One group designed a Plexiglas dome for use as a winter garden, costed it out, and designed the structure for a company to manufacture and market it. Another group compared and costed various designs for household solar heating plants and attempted to determine how high the price of fossil fuel would have to go before they could make a profit on their solar heating plant.

A third group happened to include a candlemaker and a foundry instructor from a local vocational school. The candlemaker had a business problem related to the concerns of the course: If he designed a popular candle, he would get huge orders from chain stores for that particular model but would not be able to accept the orders because he could not produce fast enough to fill them. Stockpiling was not the answer, as he did not have enough capital and could not in any case predict which candles would be ordered in such large quantity. The group decided to take the candlemaker's problem as their project and, with the aid of the foundry instructor, designed an adaptation of foundry sand casting that makes mass production of candles and candle blanks (to be decorated later by hand) possible without loss in the quality of the product. The result is the Blinding Light Candle Company, a successful small business that is rapidly outgrowing its basement factory space. This candle factory is very important to Hedman and his students, as it is the first practical, successful business to come out of the course. But they are aware that they need to succeed also in industries that are less naturally the province of the counterculture, and a group of them is now preparing to start a worker-owned and worker-managed foundry.

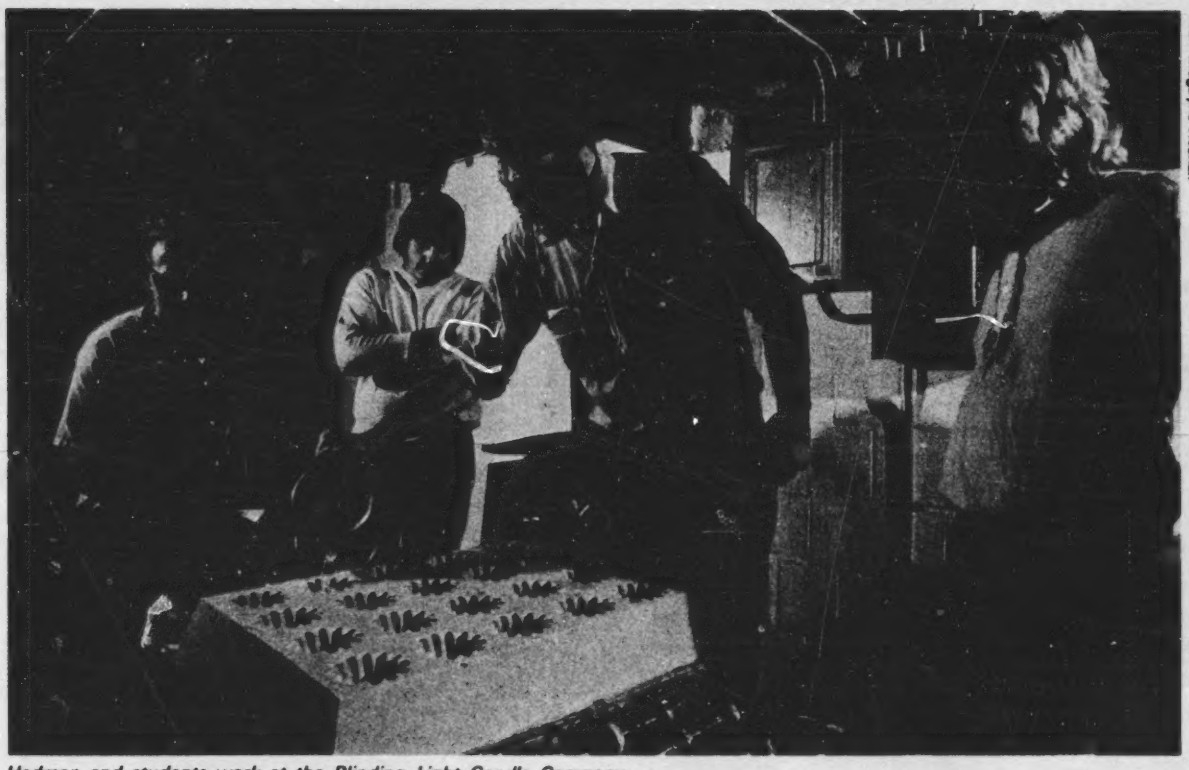
Once the projects are completed, they are not merely handed in to the professor. Acting on the assumption that the projects are significant to the community, the class runs ads and puts up posters inviting anyone on campus (or in Milwaukee) to come and hear the groups present their projects. Students working on the projects are learning not only about decentralization but also about working with each other. Each group has to decide how to govern itself and apportion the necessary tasks: Individuals within groups typically must

Alan Magayne-Roshak

Carl Hedman

Learning experience:
Perspectives in the Philosophy of Technology: Contemporary Decentralization. Prerequisite: junior standing or consent of instructor. Enrollment: 60.

Contact:
Carl G. Hedman, Department of Philosophy, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201, (414) 963-4719.



Alan Magayne-Roshak

Hedman and students work at the Blinding Light Candle Company.

learn how to deal with banks, government agencies, and raw material wholesalers, among others.

In spite of the obvious difficulty of all this, it was rare to hear of a group that had had unmanageable conflicts. Instead, it seemed that personal interests (eccentricities, hobbyhorses, obsessions) fit together to enhance the general effort. I was interested in discovering whether the "two cultures" split would persist inside the groups, with the engineers doing all the technical work and the humanities students writing about the values involved. Apparently, this did not happen; instead, students of all kinds got along together, and tasks were distributed on a nonspecialist basis.

The quality of the finished projects is uneven, partly due to variations in writing skill among the students. Some projects are worked out very thoroughly and presented with extreme care, while others are quite rough, but even the roughest of them show evidence that significant discussion and planning have taken place. Some students are doing much less work than others, but this does not worry Hedman, who refuses to be a policeman and believes the primary function of the course should be to teach students, not to grade them.

Deciding how to cope with colleagues who don't do their share is itself a part of what the groups are learning; if a group comes to Hedman with concern or resentment for an inactive member, he will help them; but he does not seek these situations out. All the members of a given group are supposed to sign the final project attesting to their work on it. Students who cannot sign receive a letter saying "Dear Friend: I notice that you weren't able to be a part of your group's final report to the class.... I urge you to talk to me soon about a paper. My office hours are...."

If the projects and the seriousness with which they are taken by most students constitute one kind of evidence for the success of the course, machine-scored student evaluations are another. Students rate Hedman's course significantly higher than other courses in the CTS program. On questions like, How would you rate this instructor's knowledge and command of the subject matter? and, What overall rating would you give the instructor? Hedman averages 4.9 and 4.8 on a 5-point scale, transcending what professional survey makers call "the ceiling effect," the reluctance of many respondents to choose the numbers at either end of the scale.

The most important indicator that the course has changed people's lives is not however, to be found in machine evaluations but in the large number of ex-students who are still in contact with Hedman and obviously consider themselves still engaged in a common enterprise with him and with each other. Many came rather long distances on a Friday night to gather at the Blinding Light Candle Company and discuss the course with me; it was clear that for many of them, the course has not ended at all.

One thing I was particularly curious about was the political attitudes of the people I met at Blinding Light. When I first read the syllabus for the course, it seemed to me that most of the texts were apolitical, addressing themselves to the question of scale without paying much attention to ownership of the means of production and the power that goes with such ownership. An orthodox Marxist would probably find these texts nostalgic and reactionary—after all, the stockholders at General Motors are not about to vote that GM be decentralized (much less worker owned and managed) if it's going to cost them money.

My interest in this apparent gap was further piqued by a dissenting student who included a personal statement in his group's project, saying: "The common denominator of this paper has been to work within and thereby preserve the existing marketplace system. I cannot agree with this position.... I submit that the need for reform is in ideology and not necessarily in the abolishment of all large-scale operations." (The mere fact of a student's submitting such a principled dissent is evidence that the students take the course seriously.)

Discussing this question of the relation of ideology to scale with Hedman's students, I found, talking as the candles were being molded on Blinding Light's assembly line, that their views were as varied as the political views of Americans in general. One student, a married factory worker with children who is working slowly toward his BA in night school, has read Marx and Lenin very carefully and agrees with their analysis but is tight-lipped and bitter about his own situation, pessimistic about the prospects for economic change.

Another, a minority woman, was quite simply and understandably out to get some for herself and saw a small business as a likely way to do it. A couple seemed naive about the relations among ownership, centralization, and profitability, seeing bigness alone as the problem. One man seemed to be happy enough with capitalism but disgusted with large-scale enterprises because they offended his craftsman's sense of pride in workmanship. Some others were counterculture students and old-fashioned American anarchists of the Thoreauvian-pastoral or cowboy persuasions.

Hedman has considered putting Marx or Lenin on the syllabus but cannot quite accept the emphasis on centralization, progress, and the benefits of technology that pervade Marxist-Leninist thinking. More importantly, he wants to avoid the feeling of helpless pessimism and passivity that a Marxist analysis of American capitalism might induce in his students. Hedman is aware that greed and stupidity often triumph (especially when backed by large amounts of capital); aware that time, food, and fossil fuels are running out; aware that Heilbroner's dismal prediction (of an age of scarcity and conflict that will collapse participatory institutions by making centralized dictatorial planning the only viable form of government) may well come true. But his instinct is to act, and then—by reflection on the consequences of one action—to determine what the next should be. He knows very well that a candle factory or even a foundry is not by itself going to change the organizational structure of our culture, but he believes that successful cooperative ventures are important models and may inspire further change. The most oppressive feature of large-scale, centralized systems is precisely the way in which they make us believe that we can do nothing by ourselves, for ourselves, that we must wait for the government or the party or the welfare department to act. Hedman is trying to help his students overcome that paralysis.

One of Hedman's most successful decentralized enterprises antedates Philosophy 338, though it currently involves his students. About four years ago, he and a handful of other adults founded Multicultural Community High School to serve students who for various reasons drop out of the public high schools. "Multi," as its students call it, simply bypasses the whole apparatus of credentials, certificates, and bureaucratic overhead, just as writers like Paul Goodman and Theodore Roszak have advocated. It has no institutional support, no certified teachers, no classroom building, no admissions requirements, no administration per se, and almost no budget—about a dollar a year per student raised from bake sales and donations. Yet it enrolls about 800 students who would otherwise be completely out of contact with school.

Classes are not required, but courses in basic subjects are offered around the city in church basements, bowling alleys, and even occasionally in school buildings. The volunteer instructors are mostly either employees of institutions donating the space or Hedman's students from the University, who learn by teaching that they have skills to contribute to the community in spite of their lack of credentials.

The basic objective at Multi is to prepare the dropouts for the High School Equivalency Test, thus bypassing the public school's monopoly on credentials, but the school also helps its students cope with court difficulties, pregnancy, job placement, and other practical problems. The whole school is predicated on the assumption that people are capable of coping, of learning by trial and error, and that indeed they have no other choice. As Hedman says, "Either you believe people can be trusted with their own lives or you do not." He does, and his whole bearing communicates his confidence in the people he's dealing with.

> **66** In his interdisciplinary course, Hedman carries his students through—and past—philosophical considerations to the creation of small-scale enterprises. Although those who regard philosophy as a purely reflective subject will feel that he has left philosophy far behind, the conviction that has enabled Hedman and his students to take on their projects is sustained by philosophical reasoning. There but for philosophy goes no one.
>
> *David Kaplan, University of California, Los Angeles*

What does all this have to do with an academic philosophy department? From some perspectives, the answer is sure to be an angry "Nothing!" But Hedman's entire career as an academic philosopher leads logically to what he is doing now. His dissertation at Columbia was on how we explain actions, and his published work on the philosophy of mind has consistently tried to make philosophical space for our common belief that we have freedom and are responsible for our actions. While working on his doctoral degree, he supported himself as assistant director of development at the Columbia engineering school and later taught philosophy at Rensselaer Polytechnic Institute, thus preparing himself for his current work with engineering students.

In addition, he has written on Rousseau's vision of a democratic society, which he argues is decentralist and would be "impossible in a highly centralized, territorially extensive nation-state." And he teaches a course on the theory of justice that juxtaposes Rousseau's vision with those of modern theorists like John Rawls and Robert Nozick. All of these interests, combined with the catalyzing effect of the Cultural and Technological Studies program, have made Carl Hedman the logical person to teach this unusual philosophy course where thought leads directly to action and where students have to *do* something to get credit. ■

CLASSICAL TO THE CORE: THE HAVERFORD APPROACH

by William McNamara

In philosophy, the Socratic method, unadorned by the plastic garlands of relevance or borne high by the evangelists of a contemporaneous vision, is hard to beat. At Haverford College, Richard Bernstein, chairman of the philosophy department, is resisting the sales pitches of the "relevantrepreneurs." And philosophy at the small Quaker college on the Main Line of Philadelphia is the gainer.

Bernstein recalls innovation's allure. He was on a panel of judges selecting from a large group of finalists the recipient of a distinguished teaching award. The group of candidates, he noticed, was divided about evenly between those who had made a name for themselves over the years as effective teachers, and those who were innovating—for whom "technique was their merit badge." The former Yale teaching star grants that technicians do bring improvement to the academic enterprise, but he is wary of the gathering horde with its "bias for tools." And philosophy is not immune to such encroachments. "It has become a specialized field, a technical discipline," says Bernstein.

Not at Haverford College, however. And especially not in philosophy. "We're more concerned with the basic issues," Bernstein declares. In that alone, Bernstein acknowledges, Haverford's philosophy faculty may not be unique. One has to look at the nature of the institution to understand better what makes philosophy at Haverford special.

The success of Haverford's classical, noninnovative curriculum owes much, he says, to the small size and intimacy of the College, to the sense of community and the concern with moral issues, to the mutual acknowledgment by administrators, teachers, and students of philosophy's importance in "confronting the fundamental questions of life." The administration, led by John R. Coleman, has been supportive of Bernstein's dogged insistence on quality, which means well-paid professors, small classes, high-powered visiting lecturers, a relaxed atmosphere for intense mental activity, and a pox on the gimcracks of mechanized innovators. Indeed, these characteristics, regarded as quaint in some of our academic powerhouses, are not exclusive to philosophy at Haverford. They permeate the place.

A century and a half ago, the Quakers of Pennsylvania thought it was time to provide a distinctive college education for their young people. This education would reflect certain basic beliefs shared by the Society of Friends: attention to rigor of thought as a prelude to action, faith in the capacity of men to live ethical lives fully, and concern for one's fellow human beings. In 1833, those precepts were embodied in Haverford College; they are sustained today to a remarkable degree in guiding the destiny of a liberal arts college that is now independent but still "Quaker-related." This humanizing influence stamps governance as much as it does the activities of classroom and recreation.

Haverford's admissions standards are among the highest in the country. Once in, the student can adjust the flexible curriculum to suit his own interests and enjoyment. The College wants the student, with faculty guidance, to develop a cast of mind that will serve him well for concentration in a variety of disciplines. More than half of the students go on to graduate school. And Haverford has more than its share of alumni among the rolls of Rhodes, Watson, Wilson,

WILLIAM McNAMARA, Change Magazine's Washington editor, is the director of government relations for the Council for Advancement and Support of Education.

and Fulbright scholars. Even though a disproportionate number enter human service fields, their mean income is higher than the national average of college graduates. And a recent survey shows that 97 percent of the graduates believe that the College contributed in a positive way to their present philosophy, attitudes, enjoyments, and satisfactions.

Almost all of the 70 full-time professors have doctoral degrees, and according to the American Association of University Professors, faculty salaries are among the highest in the nation. The student-faculty ratio is 10 to 1. And the classroom is not the end of the teaching/learning process. Most faculty members live on or near the campus, and students are their frequent visitors. Whatever their rank, seniority, or reputation, professors teach introductory as well as advanced courses.

Haverford clings to the belief that freedom to learn, to inquire, to speak, to organize, and to act responsibly with conviction, within the bounds of law, is a cornerstone of education in a free society. "For your consciences and your judgments we have not sought to bind," said Haverford President Isaac Sharpless to his 1888 graduating class. "And see you to it that no other institution, no political party, no social circle, no religious organization, no pet ambitions put such chains on you as would tempt you to sacrifice one iota of the moral freedom of your consciences or the intellectual freedom of your judgments." Haverford College today declares: "The freedom we do not allow is the freedom not to learn." Not a bad climate for philosophizing.

Even after an appreciative look at the institution, one is left with the impression that philosophy at Haverford has its own special appeal. Why else would hundreds of students line up outside overnight to register for a course in introductory philosophy? Why does philosophy attract more registrants than any other course? Students, much ma-

> "Philosophy at Haverford is not meant to breed professional philosophers as such but rather to quicken the philosophical impulse in men who would go into the ministry, into politics, into law, into writing, into business, and especially into medicine.
>
> *Douglas Van Steere*
> *Professor Emeritus*
> *Haverford College*

Edward J. Bonner

Paul Desjardins teaching philosophy at Haverford.

ligned as evaluators, probably have the best answers to these questions. Nine philosophy students, six of whom are philosophy majors, had this to say:

The superior quality of the teaching; the commanding, individualistic, charismatic character of the teachers; the symbiotic relationship between the nature of the institution and the role of philosophy; the mutual respect and beyond-classroom closeness that characterize the faculty-student relationship; a fidelity to tradition; a concern for moral issues: These are the conditions mentioned repeatedly by the students as having beckoned them to the study of philosophy at Haverford.

There are dissenters, certainly. One student remarked that the philosophy teachers had been glorified by students in their course evaluations (since abandoned). "They were enthroned as more than brilliant and sage people; they were gods." Senior Michael Arch said he perceived "a campus cult about philosophy professors."

On two occasions—two classes out of three visited one day—an observer witnessed philosophy professors dodging questions from students. "Ah, you've touched on an important question there, but it takes us off our line of discourse a bit. Let's return to it later." But "later" never happened. The questioning student seemed flattered, whether because he was complimented or because he had stumped his professor it was hard to tell. Even at Haverford the temptation for the professor to be showman, to act up to reputation rather than live up, has its victims.

Another philosophy major complained that studies in the subject "haven't helped me in my social relations." Trayton Davis is impressed with the charisma of the department faculty, but "they're mavericks in their discipline" and they slight analytic philosophy, which is stressed in most graduate schools. And that's one reason, according to Davis, why so few Haverford students go on to advanced study in philosophy. (Only one of the graduating majors intends to pursue philosophy in graduate school.)

But the preponderance of student opinion is enthusiastic approval of what they're learning and, even more pronounced, of the five faculty members in the department. Student leader Tom Sutton said, "People who come here are looking for an overview, for integrative principles. Philosophy is important to that. Almost everyone touches philosophy here, and philosophy touches him." Mark Bodner is a music major. He thought he needed philosophy to bolster him in his other courses. As a community organizer, Jim Walker said he "wanted to feed philosophical questions into what I've been doing." Even in the introductory course, he said, "Students are challenged and made to think all the time." One thought that dissuades Nicholas Harris from going on to graduate study in philosophy is that "it can never be as good as it is here." He enjoys his teachers' "strong personalities—they're not tied to the subject matter." Shanin Specter, a political science major, spoke of the awareness of philosophy throughout the College's student body.

Haverford's philosophy professors, compared with most other faculty, tend to do more with students in settings outside the classroom. Paul Desjardins, described by one student as "the conscience of Haverford," enlists his students for work/reflection/dialog sessions at his nearby home, at his retreat in the Adirondacks, or in the basement of Founders' Hall. Desjardins also has many of his students assisting him as discussion leaders in the introductory course. Mark Hulbert is one of them. And the arrangement helps him to perceive basic human issues more clearly. "You read the text—sort of dead in your hands—and then you go to class; what you thought was dead suddenly springs to life." Several students commented on the ways philosophy has revealed to them what it means to be a person. Said one: "We are exposed now to different modes of thinking about our experiences. It helps us to deal more constructively, more humanly, in our social relations."

There are, to be sure, less noble motives among the disciples. One student, dazzled by the clever parries and penetrating thrusts of his teacher in mental duel with a retreating student, confessed: "I want to be able to make people flounder like that."

No one is prouder of Haverford's philosophy forces than President Coleman. A leader who takes strong stands on controversial issues, Coleman has attracted praise and notoriety for his blue-collar pursuits when he's "vacationing." Last summer, he bagged crushed stone in a Wyoming rock quarry for a month, then moved on to other menial tasks, including dish washing and trash collecting. "I'm a good trash man," he says proudly. And with the same manner, at once pleased and serious, he extols his

Richard Bernstein, chairman of Haverford's philosophy department.

philosophy faculty. "Their spirit of collegiality can't help but have a favorable impact on the students."

Coleman was the first non-Quaker to be named president of Haverford. Now he is a Quaker. The absence of Quakers from the philosophy department faculty doesn't worry him; the department is a society of friends in its own right. In the words of Professor Emeritus Douglas Van Steere, who is a Quaker, "They are men who care for the values that Quakers hold precious, and card-carrying Quakerism has never cut any ice here at Haverford."

Though many former philosophy students have distinguished themselves as professors of philosophy and theology at prestigious institutions, "philosophy at Haverford is not meant to breed professional philosophers as such but rather to quicken the philosophical impulse in men who would go into the ministry, into politics, into law, into writing, into business, and—especially—into medicine," according to Steere. Because philosophy helps the student to integrate his learning in other fields, the College does place a special value on the subject.

Bernstein, for his part, acknowledges that and rejoices at it. As for being different from, or better than, other philosophy departments across the land, he

thinks the secret may lie in remaining classical to the core, "doing the old things well." That and the quality of the faculty, "strong individualists who share in common a concern with the great classics." All five men are good friends, which helps solidify the collegial spirit and facilitate curriculum planning. While all are seen in heroic proportions by some students, Bernstein is undoubtedly the big attraction. He is the same Bernstein who, as a young professor at Yale in the early sixties, became the center of a tenure controversy that exploded into a student uprising in his behalf. For whatever success his leadership has brought to Haverford philosophy courses, he insists on sharing the credit generously with his colleagues. Seven years ago, Bernstein received the Danforth Foundation's Harbison Award for gifted teaching. He wants others to know that three of his colleagues reached the final round of selection. And the fourth member of his faculty, who joined the department after the Danforth awards, "is clearly considered to be the best teacher at Haverford—far superior to me."

Bernstein recalls that the Harbison Award winners of his time were asked if they had received special training for their teaching roles. They answered, "No." Why then were they in teaching? Because of a role model, a great teacher who made a lasting impression. In Bernstein's case, that influence came from Paul Weiss, formerly of Yale, now at Catholic University. Integrity and facing up to the issues were the great lessons learned from Weiss. From another man, Charles Hendel, philosophy chairman at Yale, he learned the importance of "generosity of spirit," a prized thing at Haverford.

In conventional terms, Bernstein admits, he has been "very successful." He knows he is a popular and effective teacher, and he "can administer with his left hand." He knows too that exercising such abilities "can be corrupting, I could turn into a showman." Teaching for him is a "matter of character and of passion. We have to overcome self-deception." When he left Yale, Bernstein had 37 job offers.

In the classroom, Dick Bernstein is a fireball. Dressed informally, he prances around the seminar table, making a point, reading a line from Plato, shouting and cajoling, begging for clearer articulation. "This stuff is not just verbal play. This stuff has to do with real issues. Now, give it to me again, a little order here, you look like a rational man. Are you? And you, with that response. What are you, a namby-pamby? Do you know something, or don't you know something?" He retrieves his pipe from a window sill, proclaiming still, questioning, then complaining about the pinball machine effect of his dialog. "I ask a question. A student says the first thing that comes to his mind. Then he looks to see if my eyes light up." Clearly, Bernstein delighted in letting his eyes light up. He wanted more of it. In the closing minutes, he gives his subjects something to reflect on for the next session.

Aryeh Kosman, named "Super Prof" by *Esquire* in 1966, is less than ebullient about the progress of his Plato seminar. He shares his concern with his chairman: "Just not clicking yet. But I think it will come." He shares it with his students: "There's some sluggishness here that we have to overcome. We have to move. There's a lot of intelligence and good ideas here. But we're not firing together." He squats on his chair and gets into the heady subject of justice—on how moral and political principles connect. He fishes for answers he thought "would be obvious." Should our king be a philosopher? The students are divided. He moves into Plato on feminism, sunsets, photographs of old friends. He is bringing philosophy into familiar terrain. A student refers to one of the most difficult passages in Plato. "That's nice of you, but could we just go back to the divided line, and deal with that first?"

Kosman arrived at Haverford in 1962, a 27-year-old philosopher of science. "When I came to Haverford, I was supposed to be the department's logical positivist, the linguistic philosopher. After I'd been here a while, I realized how much I liked the classics." On the subject of the department's success, he says the members "disagree about a lot of things, but we agree in practice—on a commitment to rigorous intellectual standards, serious and hard philosophy. At the same time, we value teaching people who will never become philosophers."

Ashok Kumar Gangadean is tidier, more formal in appearance, as he is in class: bearded, dark eyes, grace and meticulousness converging in his conversation, in his every gesture. He introduces a question about essential properties. How much can properties change without losing their identity? The students move forward with their responses—wildly creative. He calls for criteria of identity. He brings things under control. He motions to the heavens. He is looking at the morning star. Later he is looking at the evening star. Two different names, same star. The students follow him to the stars. They drift off. He summons them: "Get back to the bite of the question." They get back, leaving the visiting observer in the remote pathways of the stars. Like the others, Gangadean returns again and again to the assigned text. "Oh, yes," he said, "we respect the integrity of the text."

Josiah D. Thompson, Jr., the fifth member of this society, is on leave this year. The author of *Six Seconds in Dallas*, he is among those who believe the nation's health demands reopening the investigation of President Kennedy's assassination. His place on the teaching roster this year is taken by Rosemary Desjardins, a classical scholar who is particularly effective with students in the introductory course: Six of her students were so impressed with her course that they went on to become outstanding philosophy majors.

The writings and conversations of these professors do not abound in theories about teaching practice, technique, methodology, relevance. "Relevance" was not once mentioned by teacher, student, or administrator during a day-long visit. They are too caught up in the exercise of it.

So we look elsewhere for their spokesmen. One of the best is Robert B. Heilman, the University of Washington's splendid scholar-critic. In *The Ghost on the Ramparts*, he has captured the working attitude and style of a Dick Bernstein in "A Chairman on Chairmanship." Like Heilman's ideal chairman, Bernstein, "insofar as he laments, laments not crimes but follies—mistakes, misconceptions, misadventures, misalliances; and necessarily he points to the deeds of good sense without which we could not identify follies." ■

Learning experience:
Philosophy at Haverford College. College enrollment: 831. Philosophy majors: 40.

Other descriptions:
None available. However visitors to the college are welcome and inquiries encouraged.

Contact:
Richard J. Bernstein, Department of Philosophy, Haverford College, Haverford, Pennsylvania 19041, (215) 649-9600.

MAKING THE SUBJECT BEHAVE

by Henry Weil

Too many teachers don't know what they're trying to teach or how to tell if they've taught it. They tell students simply, "Know the material," and congratulate themselves that their responsibility is ended. The philosophy department at Bowling Green State University in Bowling Green, Ohio, under Chairman Peter A. Facione won't settle for such easy evasions. Facione is convinced that a teacher's responsibility goes beyond a mere display of facts and theories, that the best teachers instill fundamental skills in their students. For Facione, all education is the acquiring of competencies, even the study of the history of philosophy, and he is eager to see the structure of every course in his department revised in order to isolate and convey to students all appropriate behavioral objectives.

Bowling Green State's philosophy department is well suited for shaking up tradition. First, it is young. Most of its members have come to the department since 1968, and the oldest appointment dates only from 1961. Second, nearly all the department's young turks are committed to applying philosophy to academic and personal concerns that extend far beyond the discipline's own tradition. For instance, five of the department's professors have joint appointments with Bowling Green's College of Health and Community Services where they teach such courses as Medical Ethics and the Philosophy of Death and Dying. One of them is also assigned to curriculum development.

In the undergraduate liberal arts school, one professor teaches a course in Philosophy of Law, another in Environmental Ethics, and a third teaches Philosophy in Science Fiction. There are courses in Philosophy of Film, Philosophy in Literature, and Philosophy of Punishment, and one philosopher who specializes in the history of science team teaches Philosophy of Space and Time with a physical scientist. Another philosophy teacher with an MS in computer science is preparing a course in artificial intelligence, while still another is currently preparing one on business responsibility to be team taught with an instructor from Bowling Green's Business College.

The philosophy faculty are also dedicated to spreading the word beyond the campus. Several department members are notably active in a university-run speakers bureau, while others, on a grant from the Ohio Program in the Humanities, prepared a collection of tapes on medical ethics that have been aired on regional public television. Under a second grant, others are planning a videotape series on "liberation and liberation movements."

Late last summer, Facione even managed to convince the editor of Bowling Green's *Daily Sentinel-Tribune* (the town's only newspaper) to give him a weekly Philosopher at Large column. There Facione has discussed a self-selected range of topics from a philosopher's viewpoint. He has probed the philosophy of punishment, recurrent fallacies in advertising, and the uncomfortable symbiosis between local farmers and migrant harvesters.

But probably the department's most significant commitment is to exploring the potential of competency-based teaching. One member of the department, Donald Scherer, isolated precisely what it is about philosophy that is universally applicable. Briefly, he arrived at five generic competencies: (1) the ability to think logically; (2) the ability to clarify and analyze concepts; (3) the ability to justify evaluations, which involves analyzing values, arguing soundly, and resolving value conflicts; (4) the abilities to criticize and integrate concepts into a theoretical system; and (5) the ability to think rationally, which in addition to elements of the preceding abilities involves the ability to judge the comparative acceptabilities of both factual and normative assertions.

Clearly in this sequence of abilities, logical thinking comes first. Facione is convinced that a basic logic course is as crucial to a student's education as freshman comp. And Scherer is working for the requirement of a battery of proficiency exams, including one for logical thinking, for all incoming freshmen. Under his proposal, after flunking any such exam a student could attain junior status only by later demonstrating competence in those skills.

Facione began redesigning the department's introductory course, Logic and Logical Thinking, early in 1972, intending to make logic as widely applicable as possible. The first problem, he discovered, was to isolate pedagogical goals.

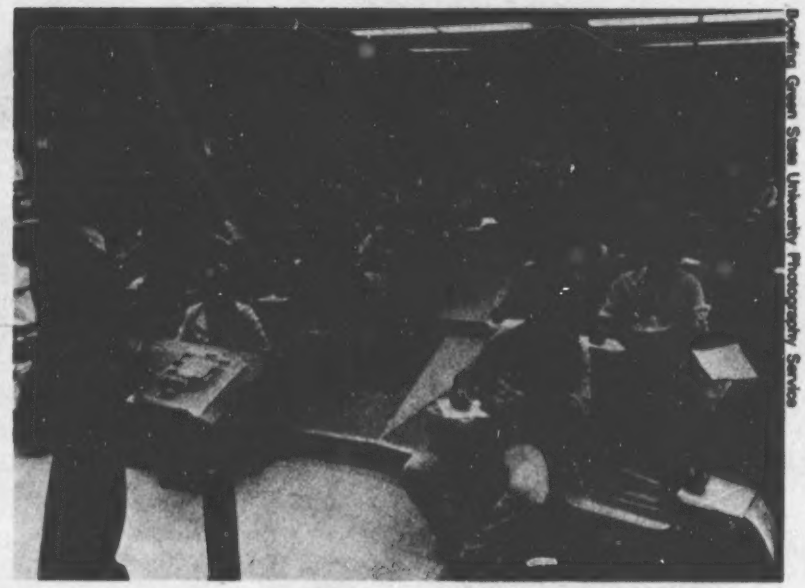
HENRY WEIL is a free-lance writer based in New York City. He has been an assistant professor at Union College in New York where he headed the drama program.

Scherer, who assisted him in redesigning the course, recalls, "In those days we probably would have described our goals like this: 'Uh...students should, er, understand the relationships between language and logic...and, uh, should be able to evaluate arguments for validity...and to locate fallacies...and, um, to construct proofs.' You know, it's tough to remember. That's going back to antiquity."

Gradually, all vague goals were translated into clear behavioral objectives ("students should be able to state the implicit but unexpressed arguments in a given paragraph," "students should be able to diagram an argument in the form of a truth table") within specific parameters ("students should be able to express implicit arguments after having spent two days studying the textbook," "students should be able to construct five truth tables in 15 minutes") and with a minimum level of competency ("and their enthymetic statements should be 80 percent correct," "no more than one truth table should contain an error"). Facione and Scherer began dividing the course into units (argument, logically correct argument, sound argument, fallacy, and proof) and assigned two overriding goals to the course: that students should increase their efficiency at recognizing acceptable arguments by 50 percent and increase their accuracy by 30 percent.

Unable to locate a logic text that did not draw its examples predominantly from the field of philosophy, Facione wrote his own text, but he was dissatisfied with it. In 1975, he and Scherer were awarded an Exxon Education Foundation grant to reshape the logic course according to Allen Kelley's Teacher Information Processing System (TIPS). (See page 24.) This format tests students frequently with noncredit, multiple-choice, computer-graded quizzes, after which the computer makes an analysis of each student's weaknesses and reports these back to the student in an individualized letter. Also, the grant enabled Facione and Scherer to rewrite Facione's text, which they divided into concise units, each of which could be easily tested by a TIPS quiz. In addition, each unit was designed to present at least one specific performance skill, clearly spelled out at the outset.

The units in turn were grouped into four major sections: Logic and Language, which drills students in recognizing arguments, classifying definitions, and building conceptual systems; Using Symbols in Logic, which teaches students to evaluate an argument's validity; Illogical Thinking, which introduces students to fallacies in logic; and Logical Thinking, which shows students how to utilize proof strategies.



Bowling Green State University Photography Service

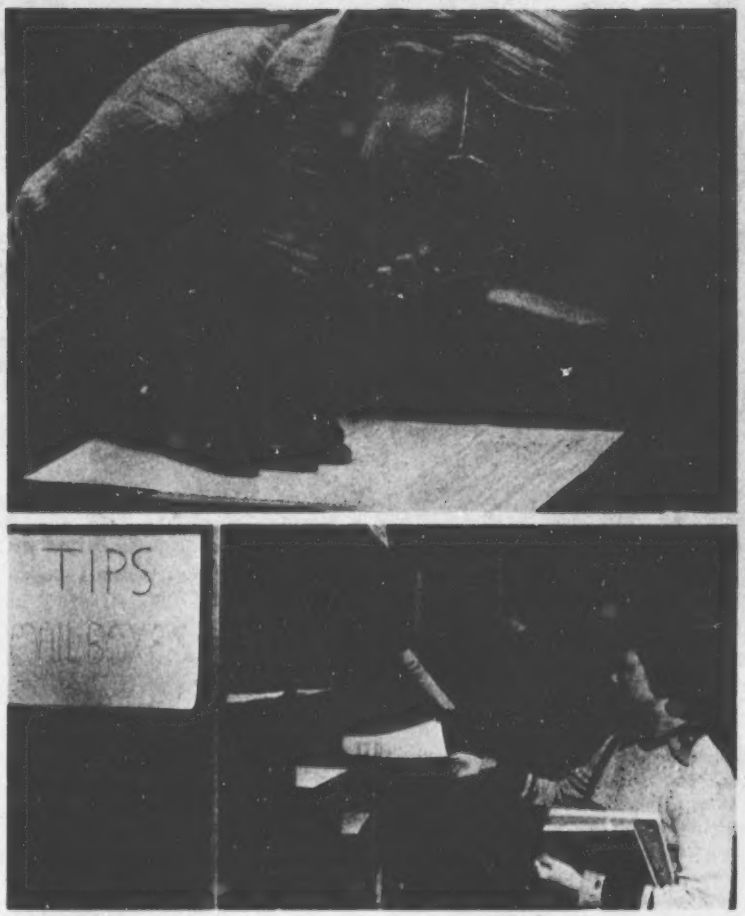
In addition to weekly discussion groups, students in Logic and Logical Thinking come together twice a week for a diagnostic quiz and a preview of upcoming modules.

These four sections are further subdivided into modules, roughly one for each hour of class. After a statement of its behavioral objective, each module contains explanatory text, followed by many exercise questions with answers provided for nearly all of them. Each answer also directs students to reread specific sections of the text in case they answered incorrectly. The few questions without answers are meant to be discussed in class. Facione and Scherer feel that their book provides a wealth of exercises unique among logic texts and a revised version (scaled down to a tenth-grade reading level) will be published later this year by McGraw-Hill under the title *Logic and Logical Thinking: A Modular Approach.*

Under the Exxon grant, Facione attended Kelley's three-day TIPS seminar at Duke University. He received Kelley's computer tape and manual (which he turned over to a computer science graduate assistant), and he and Scherer sat down to write the mass of additional TIPS rules and prescriptions that had to be fed into Bowling Green's computer. Facione and Scherer wrote approximately one multiple-choice quiz for every two modules of their texts. They provided the computer with an answer key, a weighting key (because they felt some questions were more crucial than others and therefore worth more emphasis), prescriptions for additional work to be printed out by the computer for each student, and "decision rules," by which the computer assigns students to appropriate classes (remedial, intermediate, advanced) for postquiz discussions.

With a small enrollment, the work of grading two quizzes per week and as-

> **66** Facione and Scherer seem to know exactly what they want their students to learn, and they have demonstrated a significantly more effective way to teach it. Others with equally explicit goals should be able to adopt their techniques. But a logic course must teach students not just to recognize correct proofs but to construct them. Doing the latter does not require abandoning a computer-teacher but it does require an interactive link between student and computer like that used in PLATO or the Stanford CAI logic program.
>
> *David Kaplan, University of California, Los Angeles*



Bowling Green State University Photography Service

After taking the TIPS quiz, each student receives an individual analysis from the computer that includes his or her assignment to one of three discussion groups. From the quiz analyses, Facione and Scherer can analyze where they are being most or least effective.

signing each student further study could easily be handled by a single instructor. Facione and Scherer turned to TIPS because Logic and Logical Thinking is taught four times each year at Bowling Green State, attracting an average of 200 students each fall, winter, and spring, with about 30 over the summer. The TIPS computer program manages to individualize instruction for large groups of students in a matter of minutes, a task clearly impossible for Facione or Scherer (who alternate teaching the course).

As the course is now structured, students come together each week for two sessions, each consisting of a 20-minute diagnostic quiz on assigned textbook modules and a 30-minute preview of modules to come. After class, the computer gobbles up the quizzes and prints out a message for each student, specifying which answers were wrong, what should be done about them, and which postquiz discussion should be attended. (In the event of truly calamitous performance, students are advised to see an instructor immediately.) Students are grouped in three levels of postquiz discussion according to their scores. Those who test extremely well are excused from postquiz discussion entirely and directed to proceed to the next module. Grouping students by their scores, it is believed, keeps some from becoming bored and others from being left behind. They are led on a randomly revolving basis by the principal lecturer (either Facione or Scherer) and two graduate assistants. Since students are assigned to new discussion groups after each quiz, their placement could change from week to week. According to Scherer, even the most successful students are told to come to approximately half the postquiz discussions.

The computer also maintains a data bank for each student, so that an instructor can quickly check on anyone's overall performance. It can also report on which questions give the most trouble, or which are easiest for the various discussion groups. Facione and Scherer maintain a bulging looseleaf notebook of performance breakdowns from which they can pinpoint where they are being most or least effective.

There are four hour-long, computer-graded exams for grades in the course, and though the TIPS quizzes are not counted, students can earn bonus points for them either by doing well or by presenting evidence of having completed assigned remedial work. In addition, to determine the growth in a student's logical abilities, similar tests are administered at the beginning and end of the course. Scores on the posttest also count toward the grade, but pretest scores are not counted.

There has been only light revision of

the over 600 exams from quarter to quarter since repeat questions are necessary to validate course effectiveness. A question will be rewritten, however, whenever students demonstrate its ambiguity to the lecturer's satisfaction. For example, the day I came to class there was considerable disagreement over whether a "lemon" was exclusively a "citrus fruit," as one quiz question had asserted. Several students insisted that, by popular usage, it could also be a General Motors debacle. As I drove away from the campus, the issue was still unresolved.

What has been resolved, however, at least to Facione and Scherer's satisfaction, is that the individualized instruction, competency-based approach to logic works. According to pre- and post-tests, traditional logic classes improved student scores by an average of 38 percent. Classes taught with the new competency-based text and the TIPS format have improved student scores by an average of 57 percent. Facione and Scherer compute that they have met their goal of improving student efficiency in recognizing acceptable arguments by 50 percent and that student accuracy has improved by 50 percent—20 percent higher than their original goal. Moreover, because of the pace at which learning now progresses, the professors have been able to introduce entirely new topics (monadic predicate logic and framing and confirming hypotheses) for which there had never before been sufficient time.

Facione and Scherer attribute much of their success to TIPS's swift feedback and the close apposition of class discussion to textbook assignments. Not only do the professors note more nods of student heads during class discussions, but students seem to have a much sharper grasp of their own problems. Students now begin requesting individual conferences as early as the second week of class and arrive fluent with specific questions. Professors no longer have to probe blindly for the source of confusion. The textbook has proven so efficient that several students have read it, taken the exams, and received full credit for the course on a credit-by-examination basis.

Computer costs for the logic course at Bowling Green State work out to 87 cents per student per term. This is offset by the reduction in the number of graduate assistants needed to conduct the course. In other words, more learning is offered for fewer dollars. However, there is an unexpected expense—that of the professor's time. Aware of their difficulties, students now request twice as many private conferences as they used to. Moreover, the graduate assistants, who now face students twice each week instead of once, are asked keener, slipperier questions by more acute undergraduates. Facione and Scherer have found they must now spend two to four hours each week with the graduate assistants, preparing them for postquiz discussions. Thus though professors no longer grade exams (the computer does) or lecture at any length, the number of hours needed to teach the course has in fact increased.

Bowling Green requires that students evaluate every course at the end of the term. Facione claims he has never received a strong complaint about the TIPS format or the competency-based approach. His better students do occasionally become exasperated at the format's constant repetition—but resentment is offset by swift, positive feedback that frees the students who grasp the material from further work and reduces their grade anxieties. The only common complaints Facione hears concern occasional confusion on the part of graduate assistants and the petty annoyance students feel at having to stop at philosophy department offices twice each week to pick up computerized messages.

But Facione also hears praise, and he treasures especially student comments that suggest that the logic course has proved helpful in other disciplines (e.g., journalism) and on crucial exams (e.g., law boards). Last year, Logic and Logical Thinking received the University's Presidential Special Achievement Award for Academic Excellence, which is bestowed annually by a committee representing students, faculty, and the administration. Forty awards were given last year. The logic course took one of five prizes for curriculum development.

Still, Facione and Scherer are not through refining their course. Scherer has developed a complex formula based on a student's ACT scores and his or her performance, question by question, on the pretest. This formula attempts to predict not only how well each student will do in the course, but specifically which modules are likely to cause the most trouble. By programming this formula into the computer and warning students in advance, Scherer hopes to forestall confusion.

Facione expects that as more large philosophy courses are rethought, they will also employ the TIPS format, but he recognizes TIPS limitations. Computers can only grade exams based on a student's recognition of correct answers. Admittedly, the demands of recognition can be highly sophisticated. But even so, recognition is easier than formulation. You cannot encode, for instance, the answer to, "State in your own words Hume's arguments for the following...." Ultimately TIPS quizzes are passive and well-educated students must at some point master more active competencies. The question is: At what moment must that transformation begin?

Facione and Scherer are convinced that all undergraduate philosophy courses—more, all undergraduate education—can be translated into objective behavioral competencies (both active and passive). Having seen Logic and Logical Thinking fulfill and surpass every goal set for it, they are eager to move onward. "All you have to do," says Facione, as if it were the simplest thing in the world, "is explain to a student what is expected of him to demonstrate understanding. Once that is made clear, he can't help but do better." ■

Learning experience:
Logic and Logical Thinking. No prerequisites. Enrollment: 90 to 100 per section.

Other descriptions:
"Individualizing Instruction in Introductory Logic," *Teaching Philosophy*, Spring 1977 (forthcoming).
"Pre/Post-Test for Introductory Logic," *Metaphilosophy*, Summer 1977 (forthcoming).
Logic and Logical Thinking. New York: McGraw-Hill, forthcoming.
Kelley, Allen C. *The Professor's Guide to TIPS*. Durham, North Carolina: Educational Systems Project, Box 4747, Duke University, 1975.

Similar programs:
The TIPS program of individualized instruction is used in the Introduction to Philosophy course at Drake University, Des Moines, Iowa (Burton Leiser). TIPS is used in several disciplines. For details contact Allen C. Kelley, Educational Systems Project, Duke University or the IMPACT program of the Exxon Education Foundation, New York.

Contact:
Peter A. Facione or Donald Scherer, Department of Philosophy, Bowling Green State University, Bowling Green, Ohio 43403, (419) 372-2119.

The Roving Philosopher

In the spring of 1975, Jon Torgerson, associate professor of philosophy at Drake University in Des Moines, was unhappy with the way his discipline was being taught. Watergate had done its damage, disillusion was rampant, and philosophers, Torgerson felt, had a responsibility to help in the healing process. "We were so used to dealing in esoterica that we were talking only to each other," Torgerson says. "I felt philosophy should go back to what it does best—contribute to people's understanding of social and political issues."

He also wanted to make the curriculum more pertinent for Drake's students; most are enrolled in pharmacy, law, premed, nursing, journalism, business, or public administration. He decided on minicourses highlighting the philosophical dimensions of other fields and current issues. "Career-oriented students are reluctant to take courses outside their special areas because they're afraid the material won't address their interests and concerns. One option for philosophy departments is to offer only traditional courses, leaving it to the student to figure out how they relate to his or her work. On the other hand, the department can take the offensive."

Through a National Endowment for the Humanities (NEH) project grant, Torgerson became a philosopher-in-residence as preparation for the minicourses. Operating variously as observer, student, and lecturer, he sampled courses in other disciplines, including Behavior Modification, Business and Society, and Literary Criticism. Thus forearmed, he started the program of minicourses, each of which meets for one third of a semester. Under the umbrella title Topical Philosophy, three sections are offered: one group, which shows how philosophy relates to students' career interests, includes Medical Ethics, First Amendment and the Media, and Philosophical Issues in Behavior Modification. The other links philosophy to contemporary social and political matters, and covers sections ranging from Men in Groups to Philosophy and Sex. The courses are listed as having variable credit. A student may take one or all, though demand exceeds openings.

The brief but intense nature of the minicourse calls for some originality. Torgerson stimulates discussion by dividing students into panels to analyze a specific issue. Students help choose the topics to be covered at the start of the course. Each group is given a different case and presents its analysis during the next class. The take-home final is also case analysis.

One of the most exciting features of the minicourse, Torgerson thinks, is flexibility. "The possibilities are limitless. Instead of philosophy professors teaching their own introductory courses, each minicourse could bring in a professor to teach his or her special area." For example, a traditional introductory philosophy course could be broken down into social philosophy, ethics, and aesthetics, with different professors teaching and grading each section. "The student would be exposed to a variety of viewpoints, and he could enroll for, say, just the aesthetics section. The advantage here is that a student won't have to sign up for a semester-long course in order to study the part he's interested in."

Now Torgerson is working on a series of minicourses in conjunction with other departments. To show how different disciplines touch the same issue, the philosopher's section will go into sexual morality or semantics and sexism, the sociologist will teach societal bases for sexism, and the economist will look at the possible economic costs of sexist policies. The philosophy department may also offer minicourses allied with courses in other disciplines, such as the Philosophical Basis of the American Revolution for political science students taking American National Government.

When Torgerson presented his program at the National Workshop Conference on the Teaching of Philosophy in August 1976, many wanted to know how a philosopher can teach in so many different areas. "I was educated as an analytic philosopher with a highly specialized background," he said. "But that background has given me, and philosophers in general, the ability to analyze arguments in many areas. It's a matter of putting our philosophical tools to use."

The program has made news outside the campus: Torgerson has been sought out for conferences on land use and medical ethics, written a guest editorial for the Des Moines Sunday *Register*, and been invited to speak to life insurance agents.

Minicourses involve no special expenditures for a department or university, simply a reallocation of existing resources plus the cooperation of professors in other areas. Torgerson points out that "the ease with which this can be done is shown by the way our philosophy department absorbed the program after the NEH grant expired, and by the fact that history and mathematics faculty have adopted minicourses."

Professors in several disciplines are delighted with a format that permits them to concentrate on a single aspect of course material. Students welcome the opportunity for a five-week dip into material they wouldn't have been able to study before without investing a semester.

The series was evaluated by Julie White, assistant director of project grants for NEH, and Norman Bowie, executive secretary of the American Philosophical Association, who was serving as a consultant to NEH. After interviewing students, faculty, and administrators, Bowie wrote in his report to NEH, "The minicourse topics are ideally designed to address a fairly narrow interest for a brief but intense period. Our discussion with students clearly indicates that many of them prefer this approach to the introductory humanities courses.... The courses have the potential for actually improving the quality of humanistic education at Drake."

For more information: Jon N. Torgerson, Department of Philosophy, Drake University, Des Moines, IA 50311, (515) 271-3748.

Many Courses in a Single Open Classroom

Walter Coole, professor of mathematics and philosophy at Skagit Valley College in Mount Vernon, Washington, once videotaped one of his math lectures so he could see how students responded to them. While viewing it, he fell asleep. It confirmed his determination to find a better way to interact with students.

Skagit Valley is a two-year community college with the usual heterogeneous mix: academic transfer students, full-time workers, vocational students, those with BAs who are filling in deficiencies before going on to graduate school, and older people studying avocationally. Coole thought that a format that would allow him to offer a broad curriculum and flexible class meetings would suit students' needs better than lectures, for which neither he nor his students had any enthusiasm. He was tired of having to close down courses when he didn't get the minimum enrollment. He also believed there wasn't enough stimulation for the community college teacher: "We survive a long process of intellectual culling, sharpen our wits with exquisitely subtle stuff in graduate school, then spend the rest of our lives on the treadmill of lower-division courses."

In 1969 the administration announced its willingness to try new ideas. Coole jumped at the chance to begin an open classroom. The open classroom offers three disciplines: philosophy, including Introduction to Philosophy, Introduction to Ethics, Informal Logic, and Elementary Formal Logic; mathematics, which includes 11 courses from high school arithmetic to calculus; and learning skills, which covers listening, note taking, and following directions. Coole also originates philosophy courses as the need arises, usually vocational applications of logic and ethics. The number of credits per course varies, and all students may negotiate learning contracts to do more advanced work to improve grades or earn additional credits.

Skagit Valley's academic year is divided into four 11-week terms. The open classroom operates day and evening. A student may enroll at any time and still take 11 weeks to complete his course or courses. When a student checks in for a philosophy course on the first day, he's given a brief talk on the open classroom's procedures and a copy of the syllabus, which lists course goals, assignments, and the text. It also describes levels of learning he should achieve at four points in the course, distributed over the term to provide for safe progress to the end. He selects a pair of twice-weekly meetings from a choice of 13 time slots. These are the only times the student must be present in the classroom, though he may drop in as often as he likes. He does the rest of his learning by himself or in student-managed groups, using the textbook and recorded lectures.

Course meetings include from five to twenty students. They may all be taking different courses. An Informal Logic student planning to transfer to a four-year university might sit across the table from a policeman in an advanced course on the law enforcement code. "Each student is responsible for keeping track of his own progress and calling for help when he needs it," Coole says. "Students primarily help each other. If an algebra beginner complains about having to learn factoring, the calculus student in the next chair can explain better than I can why it's important. You hear these conversations in the coffee shop all the time. Advice from a professor or counselor goes in one ear and out the other; but when a sophomore tells a freshman, it sinks in."

Coole will step in to assist a student who has hit a stalemate on a philosophical question. "Here's where the teacher as model comes in—I walk through the material with him. I could never do that for each student in a traditional course. Just a little guidance through the thinking process makes the difference."

About 10 percent of the way through a course the student completes a survey form. It asks for his thoughts on the course objectives, how easily he's getting started, and whether he thinks he has enough help. Coole uses this to spot trouble early. At meetings each student discusses what he's currently working on, how much he's learning, and why he needs to pursue it. Students also help one another, confer with Coole, or listen to taped lectures.

When Coole feels he's ready, a student may attend only one meeting per week, as long as he continues to progress. He may take the final exam whenever he completes the assigned work. If he passes, he's given a B. To get an A, he must negotiate a contract to become a student coach, write a term paper, or pass a tough essay exam. Eighty percent choose to go for the A. For instance, a philosophy student may become a coach specializing in logic. Since Informal Logic is a three-credit course, he must spend three hours a week helping students locate self-instruction materials and understand what they're studying. "The benefits of coaching work both ways," Coole observes. "If someone is having trouble with the principle of the excluded middle, the coach may have to explain it eight times, always trying a new attack. The student finally gets the idea; the coach becomes an expert."

The program's flexibility, Coole believes, has enabled many students to learn who might not otherwise have been able to do so. A highway patrolman on rotating shifts was placed on a special list of students who are allowed to attend any one meeting they can make during a week. The open classroom was the only program that fit his work schedule. A 55-year-old divorcée started with learning skills, completed the 45-hour course in four days, finished basic algebra in three weeks, then went on to intermediate algebra. By Christmas she began college algebra and came back in January ready for trigonometry. A high school student of 15, having completed every advanced math course her school offered, was permitted to take college math courses. Social agencies often refer people to Coole.

Students say they prefer the reading and independent study to lectures. They like the program's varied options and rich curriculum and the fact that feedback comes much faster than in a conventional course.

For more information: Walter Coole, Open Classroom, Skagit Valley College, 2405 College Way, Mount Vernon, WA 98273, (206) 424-1031.

Seek-Your-Own-Depth Philosophy: A Community College Solution

Teaching philosophy, as indeed teaching any academic course in a community college, poses a special challenge by the very nature of the institution. The community college is generally a career-oriented two-year school serving students with exceptionally broad-based backgrounds and interests. The young and old, fast and slow, minimally curious and more reflective, sit cheek by jowl in large classes. Because of job pressures, farm chores, and parental responsibilities, emergency absenteeism is usually high.

Conceivably, the college may offer only one philosophy course. How, in it, can the needs and expectations of all be met?

Problems in Philosophy at Brookdale Community College in central New Jersey is designed to meet this challenge, in keeping with a seek-your-own-depth program used throughout the school. It is essentially a freshman course suited for those with little or no prior exposure to the subject. The text is James Christian's *Philosophy: An Introduction to the Art of Wondering*. Fifteen broad areas are explored: from values and modes of truth to man and nature, time and space, death and meaning, ethical determinants, cosmic evolution, images of God, knowledge and skepticism. The student who simply wishes to pass the course for required credit can do so. He or she can rely almost exclusively on the text and is guaranteed not to fail.

But the Brookdale student can, within the course framework, take deeper plunges if he so chooses. Two additional levels of achievement are offered. Objectives and work requirements for each grade are made clear at the term's outset and are basically the following: For credit (a C, the passing grade) the student is expected to learn something factual of the 15 topics' fundamental issues and prove it in a short-essay final. (Sample question: What was the relation of philosophy to belief in the Middle Ages?) Some 90 percent of what must be learned is in the text, the rest in secondary sources such as filmstrips available in the library. A grade of 70 is passing. Flunkers get retests after review and/or remedial assignments. Nobody fails (although the student can opt for another Brookdale course if not even the C-level objectives appeal to him).

For credit honors (a B) the student adds short, introductory, primary-source readings in any four topics of his choice. The final is a take-home: one question relating to all four topics. (Sample: What does the behaviorist imply about the nature of men?) For credit high honors (an A) the student, with the instructor's approval after consultation, undertakes original, speculative work in one topic or on one philosopher; the final is an oral. All students keep periodically evaluated journals of definitions and other material to satisfy the requirements; B and A strivers in addition write interim papers on their primary-source readings.

Refinements in the program provide still more flexibility in the community college situation. Classroom attendance is not mandatory; all objectives can be met through self-study at home. Of particular benefit to absentees are cassette recordings of classes' high points made available in the library. (The tapes are also useful to late enrollees and, of course, to exam crammers.) Any student who needs extra time can, for a minimum fee, arrange to defer credit past the end of the semester. And those who have achieved credit, at the C-level for example, can take as long as a year to improve their grades, continuing the course on a personalized basis; this accommodates interests that grow as the term progresses.

All this may be a drain on time and energy, particularly for the new instructor at Brookdale, who is in a sense teaching three classes in one, each with its own outflow and inflow of assignments. But the program's benefits outweigh costs. A portion of Brookdale's state and locally funded budget has been allocated to its development; the groundwork has been laid. The new instructor finds the way somewhat eased and the students, once initiated, almost universally appreciate their options.

No program in itself can solve the familiar classroom problem: to introduce and sustain exciting philosophical discussion. Generally, Brookdale students want to pass their tests; instruction still tends to stick pretty closely to basics in the assigned topics. But insofar as all formal requirements can be met with the use of out-of-classroom sources—and the students know this—a certain amount of class time can be used more creatively, depending on inspiration and student desire.

Questions raised in Brookdale classes tend to be psychologically oriented, regardless of the topic: Do I have a real self? Is there a real world and how can I know it? What could I hope to learn of man and nature if I were born and lived in a plastic bag immersed in body-temperature water? Can I grow younger again?

A reading source for the last question is James Coleman's *Theory of Relativity for the Layman*; a corollary speculation centered on the possibility of having an identical twin younger than oneself. On the self-and-reality questions, David Hume ("self is a series of fleeting perceptions") and Freud on inner conflict may be read in preparation for classroom discussion. With regard to the person in the plastic bag, a free-for-all debate allowed him sensory input from his heartbeat and thrashings about; thereafter the discussion on the philosophical question of whether or not the self exists outside of society required temporizing.

Brookdale does offer two further philosophy courses, Logic and Comparative Religion, plus a self-study program in special projects. But Problems in Philosophy seems to satisfy the majority. Students say so, and it can be surmised from the depth of their thinking that minds have been opened. From the pedagogical viewpoint, increased availability of supplementary aids (slides, films, autotutorial computers) would be appreciated; these projects will take time and money.

Challenging students' opinions and prejudices, sharing their discoveries, can be a rewarding experience for a philosophy teacher at any college; once the necessary accommodations have been made, it can be none the less so at a community college.

For more information: Robert B. Mellert, Human Affairs Institute, Brookdale Community College, Newman Springs Road, Lincroft, NJ 07738, (201) 842-1900 x369.

SUBJECT INDEX

The learning experiences presented in the first three Reports on Teaching are included here in two indexes—a subject index and a faculty index. The subject index is designed for those interested in a particular approach to teaching. It is divided into four main headings: (1) teaching strategies, including various techniques used in the learning experience from lecturing and team teaching to the use of multi-media and computers; (2) focus, indicating the general direction of the studies, whether for career orientation, underprepared students, etc.; (3) evaluation, noting various approaches to grading; and (4) course management, listing those learning experiences that are interdisciplinary or a modification of the traditional approach.

Subheadings are listed alphabetically, and each entry includes the name of the professor, the number of the Teaching Report in which the course is described, and the page number. The number preceding the colon in each entry refers to the Report number; the number following the colon refers to the page number. Thus 2:47 indicates Report on Teaching #2, page 47. Report #1 (March 1976) includes undergraduate teaching in chemistry, history, and psychology; Report #2 (July 1976) includes biology, English, and political science; and Report #3 (January 1977) covers economics, mathematics, and philosophy. For a complete listing, including field of study, institution, and the title of the article, the reader should consult the faculty index that begins on page 70.

TEACHING STRATEGIES

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